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THE

OPERATIONS OF SURGERY

INTENDED ESPECIALLY FOR THE USE OF
THOSE RECENTLY APPOINTED ON
A HOSPITAL STAFF

AND FOR

THOSE PREPARING FOR THE HIGHER EXAMINATIONS

BY

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W. H. A. JACOBSON

M.A. M.B. M.CH. OXON.; F.R.C.S.

ASSISTANT-SURGEON GUY'S HOSPITAL; LECTURER ON ANATOMY, LATE TEACHER OF
OPERATIVE SURGERY IN THE MEDICAL SCHOOL; SURGEON TO
THE ROYAL HOSPITAL FOR CHILDREN AND WOMEN

SECOND EDITION

WITH TWO HUNDRED AND THIRTY-FIVE ILLUSTRATIONS

LONDON
J. & A. CHURCHILL
11 NEW BURLINGTON STREET
1891

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TO

THREE OLD FRIENDS

ARTHUR EDWARD DURHAM
JAMES FREDERIC GOODHART
EDWIN CLIMSON GREENWOOD

I Dedicate this Book

AS SOME SLIGHT TOKEN OF MY GRATITUDE
AND AFFECTIONATE RESPECT

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PREFACE TO THE SECOND EDITION.

I WAS unprepared for the rapid sale of the first edition, and the book has consequently been out of print for twelve months.

This delay will, perhaps, be excused when it is remembered what time and trouble are needed for an attempt to bring a book like this up to date, and to make the needful alterations and additions.

Amongst the former it may be noted that the chapters on the results of Otitis Media, Brain Surgery, Extirpation of the Larynx, Inguinal Colotomy, Nephro-lithotomy, and Cholecystotomy have been largely rewritten; while the additions include sections on Anæsthetics, Antiseptics, Diagnosis of Renal Calculus and the conditions which simulate it, Calculus in the Ureter, Intestinal Anastomosis, Typhlitis and Appendicitis, Rupture of the Intestine, Pancreatic Cysts, Tubercular Disease of the Bladder, Prostatectomy, Erasion of the Knee, and many minor ones.

The plan of the book, with which some of my judges found fault, remains unchanged. I adopted the division by Regions deliberately, desiring that, by those for whom the book is intended, the Anatomy of each region should be studied at the same time as the Operations.

It remains for me to acknowledge very gratefully the encouragement given me by my reviewers, and a host of correspondents from all parts of the world. I only wish that my book deserved better the kind things which they have written of it.

66 GREAT CUMBERLAND PLACE,
HYDE PARK, W.
June 1891.

PREFACE TO THE FIRST EDITION.

THIS book is the outcome of a strong belief, which I have held for many years, that a work on Operative Surgery which aimed at being more comprehensive in scope and fuller in detail than those already published, would be of service to many who had recently been elected to hospital appointments, and to those who were working for the higher examinations.

I most gladly take this opportunity of acknowledging my good fortune in being able to profit by the facile pencil and the cultivated knowledge of my old dresser and friend Dr. C. W. Hogarth, of Brixton. His happy combination of Art and Medicine, and his friendly patience in carrying out my wishes, have been to me a saving of much trouble.

To Messrs. Churchill I owe the opportunity of making use of some of those drawings by Thomas and William Bagg which were so well known in the pages of that master of his craft, Sir W. Fergusson.

Dr. E. W. Goodall has kindly supplied the list of errata. While it testifies to the carefulness of his reading, I trust that allowance will be made for its length by those who know something of the calls upon my time.

66 GREAT CUMBERLAND PLACE,
HYDE PARK, W.
December 1888.

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SOME HINTS ON THE ADMINISTRATION OF ANÆSTHETICS.

I DO not for a moment pretend to deal with the subject completely, or that my remarks come with any especial weight. They are merely the outcome of almost constant work in surgery for one-and-twenty years.

I commence with a few APHORISMS.

I. *There is as yet no perfect anæsthetic.*—This is shown by the remarks made below on the advantages and disadvantages of ether and chloroform. II. *There is no absolutely safe anæsthetic.*—As ether, though not absolutely safe, has largely replaced chloroform, so ether in its turn may give way to some anæsthetic safer still; but it is not likely that any drug which is powerful enough to bring a patient into a condition in which he is on the brink of his grave will ever be absolutely safe, especially when the visceral and mental conditions of our patients are remembered. It may be permissible with very nervous subjects to talk of "putting a patient to sleep," but there is no real comparison between surgical anæsthesia and sleep. In sleep a comparatively slight stimulus will arouse the patient, but in perfect surgical anæsthesia "nothing remains of life but the organic functions, the nervous centres are paralysed down to the parts presiding over respiration and circulation. Life hangs in a tremendous balance. No hands can be too skilled to hold the scales."* III. *Deaths from anæsthetics are most frequent in operations for trivial cases,*† when the administrator is liable to be off his guard, and when the friends are certainly least prepared. IV. *So-called deaths from anæsthetics really fall into certain groups:* (*a*) Deaths due to the anæsthetic which has been carefully administered; (*b*) deaths due to the anæsthetic which has been carelessly, often hurriedly, administered; (*c*) deaths due not so much to the anæsthetic as to some disease present in the patient, or, much more rarely, to his mental condition. V. *Two golden rules should be remembered during every administration:* (1) While enough of the anæsthetic should be given to ensure complete insensibility before the surgeon commences, and while he is operating; (2) Care should be taken that the patient has no more of the anæsthetic than is absolutely needed. While neglect of the first rule causes great inconvenience and waste of time, neglect of the second is sometimes responsible for loss of life, and more often for the prolonged vomiting and malaise which often interfere with the after-treatment.

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* Sawyer, *Brit. Med. Journ.*, 1875, vol. ii. p. 727.

† See the lists repeatedly published by Dr. E. H. Jacob—*e.g.*, *Brit. Med. Journ.*, 1880, vol. ii. pp. 998, 999; *ibid.*, 1883, vol. i. p. 354. On this account cocaine (*vide infra*) should be more largely tried in minor operations.

CAUSES OF DEATH AND DANGER FROM ANÆSTHETICS.—i. *Syncope.*—This failure of the heart is a very common cause amongst deaths in chloroform administration, and usually occurs early in the administration.* Sometimes it sets in later on, usually from the administrator forgetting the cumulative effect of the drug, and a fresh dose thus proving an over-dose. The evidence of the onset of syncope is a feeble, fluttering pulse which stops suddenly, ghastly pallor, sudden extreme dilatation of the pupils, stoppage of breathing, and cessation of hæmorrhage. The treatment is immediate lowering of the head, raising the lower end of the table, or holding the patient up by the heels.† This advice of M. Nélaton not only quickly restores blood to the brain, but, as pointed out by Prof. Chiene (*Pract.*, vol. xviii. p. 31), helps to remove any obstruction about the glottis. As the breathing will have ceased with the stoppage of the heart, artificial respiration should be performed, the windows opened, and any crowding round the patient prevented. Tracheotomy is very rarely of any avail; before it is performed the surgeon must make certain that air does not enter the chest. Subcutaneous injections of ether and brandy, if given at once, may be useful. Of the much vaunted inhalation of amyl nitrite, electrical stimulation of the heart, or acupuncture of it, I can only say that I never saw one of them of the least use. They have all, however, been sanctioned by very high authority.

ii. *Respiratory Troubles.*—These may occur in very different ways: (*a*) *Falling back of the tongue.*—The upper aperture of the larynx may thus be closed in the administration of any anæsthetic. The signs are those of asphyxia, and the accident must be met by pulling forward the tongue, and turning the head on one side. It may often be prevented by keeping the angle of the jaw forwards. (*b*) *Swelling of the tongue.*—This is usually due to ether, and is not common. The jaws must be forced open with a gag, and the tongue pulled forward. These failing, artificial respiration must be performed. When the asphyxia has passed away, chloroform diluted with pure alcohol (1 part alcohol to 4 of chloroform) must be given. (*c*) *Closure of the glottis by falling together of the arytæno-epiglottidean folds.*—This may come on without any stertor, and, as pointed out by Sir J. Lister, may be overlooked till too late, as the movements of the chest and abdomen may still continue without doing anything for respiration. The tongue must be at once well pulled forwards, and artificial respiration performed if needful. (*d*) *Collection of mucus about the fauces and upper laryngeal opening.*—This is very common with ether. It must be met by careful sponging (not too vigorously, lest irritation of the mucous membrane increase the mischief), turning the patient on one side, and, if needful, using chloroform and alcohol. (*e*) *After-bronchitis and pulmonary œdema.*—This is a danger which is inseparable from ether,* with its irritating effect on the air-passages, if it be given for very prolonged operations, and if it be wrongly given—*i.e.*, in an impure form, in excess, and in patients whose lungs are already the seat of chronic bronchitis, &c.† The treatment of these cases is mainly preventive—*i.e.*, not persisting with ether when it is evidently too irritating for the patient. When once the condition of after-bronchitis and pulmonary œdema is established, very little can be done. Artificial respiration does very little to improve the cyanotic, comatose condition. Perhaps vomiting, induced by an injection of apomorphia, might help to clear the choked tubes, but it is not, of course, without danger. A small bleeding may also be tried. (*f*) *Spasm of the respiratory muscles.*—This rare but terrible condition may occur with ether or chloroform. A good instance of the latter is recorded by Sir J. Lister (*Syst. of Surg.*, vol. iii. p. 615). A healthy man, aged 27, being placed under chloroform for the opening of a lumbar abscess, fell after the struggling stage into a sort of epileptiform condition, attended with a state of spasm of the respiratory muscles and widely dilated pupils, while the face was deeply livid.

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* In a few cases syncope may be due to other causes than the anæsthetic—viz., tremor, or cutting the cutaneous nerves when an operation is commenced before anæsthesia is complete. All sources of fear—*i.e.*, describing the operation befor the patient, or handling the part about to be operated on—should be avoided unti unconsciousness is complete. Another cause of syncope is a too elevated positio of the head.

† The return of blood may also be favoured by firmly stroking the limb upwards towards the trunk.

iii. *Nausea and Vomiting.*—While there is often a difference in the vomiting which follows ether and chloroform, the former being violent, explosive, and soon over, and the latter more prolonged, either anæsthetic may be followed by troublesome and, for a while, intractable vomiting. This is especially likely in neurotic, nervous patients in whom the digestion of the last food taken is often thrown into abeyance, in the weakly and those of the flabby and lymphatic type, and after operations where blood has been swallowed. The treatment is mainly preventive—*i.e.*, enforcing the rule‡ that the last food (very simple in character and moderate in amount—viz., bread and milk, or beef-tea, or soup, or jelly§) should be taken three to five hours before the operation, keeping the head low, and the patient absolutely quiet afterwards, ventilating the room well, and allowing no food for from three to four hours afterwards. As a rule, a little cold soup or beef-tea, meat jelly, bread boiled in milk, to which a pinch of bicarbonate of soda has been added (Buxton), or sponge cake soaked in a light, dry sherry (Buxton), may be given after this time. For the severer forms of nausea and vomiting which are sometimes so persistent, the best course is to keep the stomach empty, frequently wash the mouth and lips with iced water, but allow nothing to be swallowed, and to feed by enemata. Occasional spoonfuls of iced soda-water or champagne are, at times, useful. Allowing the patient ice *ad libitum* is usually harmful, leading as it does to keep up the vomiting, and to cause subsequent epigastric distress. Many remedies—*e.g.*, drop doses of tr. iodi, vin. ipecac., dilute hydrocyanic acid—have been recommended, but I have seen little reason to put any faith in them. The following (Buxton) are worth a trial :—Teaspoonfuls of *hot* water, merely tepid water provoking vomiting—Mr. Buxton advises that the use of metal spoons be now avoided for fear of blistering the lips and tongue; iced black coffee with bromide (gr. x to a small cupful) is also useful. For the hiccough, which is sometimes very severe after ether, if morphia fail, the same authority recommends sipping mustard in very hot water (ʒj–℥iv), or a small cup of strong green tea taken hot, and without sugar and milk.

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* Patients after any prolonged anæsthetic are especially liable to chill. Care should always be taken that they are well wrapped up, and not exposed to draughts, especially if a window has been opened to get rid of the anæsthetic.

† Though a strong advocate of ether or A.C.E. in preference to chloroform, I quite admit that there is a risk (as pointed out by Mr. Hodges, *Lancet*, July 15, 1882) of these deaths not being reported, as they do not occur instantaneously (as in the case of chloroform), but some hours later from bronchitis.

‡ This is especially important in out-patient practice, where patients are not under surveillance.

§ Mr. Dudley Buxton (*Anæsthetics*, p. 12) advises that weakly patients with

CHOICE OF AN ANÆSTHETIC.—I speak here only of ether, A.C.E., chloroform, and chloroform and alcohol, of which alone I have any experience. They are also the only anæsthetics in use by ordinary administrators, to whom alone these remarks apply. While, as already stated, there is no absolutely safe anæsthetic, it is increasingly admitted nowadays that ether or A.C.E. are safer anæsthetics than chloroform for general purposes. If any one doubt the correctness of the above statement, I would refer him to the medical journals of the last fifteen years; to the opinion of Mr. Jonathan Hutchinson,* whose experience is enormous, and whose powers of observation are without equal; and finally, to the practice of the leading anæsthetists of the present day.

Ether and A.C.E.—*Advantages.*—Ether is a powerful cardiac stimulant. When harmful or going to kill, it almost invariably gives warning. Coming round is far more rapid, and accompanied with much less depression. *Disadvantages.*—Its bulk. Its more pungent and disagreeable smell—disagreeable at the time, and more liable to hang about afterwards. Its tendency to cause secretion of mucus in the fauces, irritation of the air-passages, and occasionally, especially after a prolonged operation, or an over-dose, to leave the patient in a condition approaching to stupor

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feeble heart action should have one or two table-spoonfuls of good spirit and water about half an hour before the operation.

[*] "Ether *v.* Chloroform" (*Brit. Med. Journ.*, 1880, vol. ii. p. 760), and "The Choice of Anæsthetics": Canons in Surgery, *Arch. of Surg.*, vol. i. No. 2, p. 118.

and cyanosis. Its greater liability to cause struggling and shouting, especially in alcoholic, muscular, and excitable patients.

Chloroform.—Advantages.—Its smaller bulk, its greater facility in the hands of novices of administration, and its less objectionable smell. *Disadvantage.*—The above advantages, great as they are, are all outweighed by the terrible drawback to chloroform—viz., that it is a cardiac depressant. Furthermore, when it kills it does so without warning, insidiously, and often in a moment.* Save in a few instances—*e.g.*, infants, old people, cases of unsound lungs, in warfare, owing to the greater portability of chloroform, in hot climates, in operations where the cautery has to be used near the mouth, and in the special cases given below—ether or A.C.E. is to be preferred to chloroform.

POINTS IN ADMINISTRATION.—The usual precautions of an empty stomach, removal of false teeth,† and any tightly fitting clothes, the recumbent position, are enforced. and an absolutely pure drug is ensured. As to the best inhaler for A.C.E. or ether, I am strongly in favour of uncomplicated instruments for ordinary hands. While Clover's apparatus has the advantage of requiring a comparatively small amount of ether, and of securing a tolerance of the vapour by gradually increasing the anæsthetic, I think a simple felt cone (these are easily obtained in different sizes), with a sponge which has just been wrung out of very hot water, or a towel folded in a cone and containing a sponge, are preferable, on account of the amount of air which is thus admitted. However ether is given, the administrator should remember that his object is to skilfully anæsthetise, not to violently asphyxiate the patient. When the A.C.E. mixture is given, the different rates of evaporation of its constituents must be remembered, and a due supply of ether maintained by frequent renewals of the mixture in small amounts. If chloroform must be given, a Junker's inhaler is the best, and the next a Skinner's and a drop bottle, if the administrator will remember how terribly easy it is with this latter method to give an excessive and perhaps cumulative dose, if a fresh supply be forgetfully dropped on while the flannel is already charged.

Much has been said as to whether the respiration or pulse should be watched. It is easy for the administrator to keep himself duly informed of both by watching the movements of the chest ‡ and the colour of the lips. As long as the latter are red the circulation is satisfactory; pallor or lividity are danger-signals. While the patient is still sensible the dose of ether in the cone must be frequently renewed, care being taken to give the same amount each time. As soon as full anæsthesia is induced, unconsciousness should be maintained with as little anæsthetic and as much air as is safe. While it is always well to preface the administration of ether (especially in excitable, muscular, and alcoholic patients) by giving nitrous oxide gas when the somewhat cumbrous apparatus for this is at hand, I look upon the recommendation of some to begin with chloroform and go on with ether as very dangerous. The great majority of deaths with chloroform take place quite early in the administration. The over-secretion of mucus, which may be very troublesome with ether, is best met, not by sponging out the back of the mouth, which only aggravates the trouble, but by keeping the head on one side, and thus allowing the mucus to collect in one cheek, from which it can readily be removed.

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* Any one studying the fatal cases will be struck by the great number in which chloroform has killed, and killed suddenly, healthy or fairly healthy patients, usually submitted to a slight operation, but little of the drug having been given, and that carefully.

† It is well in the case of women to ascertain the existence of these, not by direct questioning, which may offend. but by requesting leave to look in the mouth.

‡ Watching this is to be preferred to keeping an eye on the abdomen, which latter may be fallacious, it being possible for the diaphragm to heave up and down without much air entering or leaving the chest. Whilst lividity usually only means that the patient has had enough, shallow, gasping, and above all irregular breathing are very ominous.

SPECIAL CASES.*—i. *Collapse and Asthenia.*—Amputations for railway injuries are an instance of the first, and those for bone disease with prolonged suppuration of the second. In such cases, if the patient can be got to respond sufficiently to warmth to bear the operation, he may take an anæsthetic. Here ether with plenty of air, or the A.C.E. mixture, are indicated, together with the precautions against shock which I have given at p. 1031. Comparatively little anæsthetic will be required now.

ii. *Cardiac Disease.*—Where the action is feeble and irregular, whether from valvular disease or fatty change, a very important question is the condition of the lungs and pleural cavities. If there is no bronchitis, œdema, or effusion, the A.C.E. mixture is the best. If there be evidence of embarrassed lungs, chloroform with a little alcohol (p. xvi) should be given.

iii. *Lung Affections.*—Where there is dyspnœa or cyanosis—*e.g.*, in advanced phthisis, empyema, pulmonary œdema, bronchitis—chloroform diluted with alcohol is to be preferred. And the same should be the rule where the chest is encroached upon, or the air-passages narrowed as by aneurism.

iv. *Abdominal Surgery.*—Where the abdomen is much distended, as by a very large ovarian cyst or an obstruction, where the patient is liable to vomit, where there is much straining with A.C.E., chloroform diluted with alcohol should be employed.

v. *Renal Disease.*—A.C.E. or chloroform diluted with alcohol, according to the state of the lungs, &c.

vi. *Advanced Atheroma.*—Chloroform alone, or diluted with alcohol.

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* Excellent directions under this heading, from which I have taken many hints will be found in a post-graduate lecture by Dr. F. G. Hewitt (1889) and in paper by Mr. Marmaduke Sheild (*Proc. Med. Soc.*, vol. x. p. 129).

should be given. Atheromatous vessels may easily give way under the great congestion of etherization.

vii. *Cerebral Surgery.*—Anæsthetics must here be always given with much caution, especially when any intracranial pressure is present (p. 154 *). Chloroform with or without alcohol dilution is indicated here, owing to the lessened vascularity and the fact that pulmonary œdema is often present in these cases. The preliminary injection of morphia has been recommended in these cases, as rendering the administration safer,† more satisfactory, and at the operation less accompanied with bleeding. This step is not one to be lightly undertaken. Dr. F. G. Hewitt (*Pract.*, vol. xxxix. p. 103) points out that "the sedative action which the drug exerts upon the respiratory functions might, in a person susceptible to its influence, or in one whose respiration was enfeebled or embarrassed, produce symptoms of a most alarming kind." A very interesting case is quoted in support of the above, and a little later (p. 105) the following weighty sentence follows :—"The susceptibility of patients with cerebral disease to morphine is well known, and is especially to be borne in mind when any tendency to coma exists. When a patient is placed under an anæsthetic he is artificially rendered comatose, and in the event of any symptoms of respiratory paralysis (whether from the anæsthetic or not) arising, such a patient would have a smaller chance of recovery than if his respiratory centres had not been lulled by opiates."

viii. *Operations about the Mouth and Jaws.*—Ether may usually be satisfactorily given unless contra-indicated by the age of the patient, or any lesion, cardiac, pulmonary, &c. The great secret of success in these difficulties is to ensure getting the patient thoroughly under before he is touched by the surgeon, and sufficiently deeply to allow of the operation being completed without much more of the drug being required. Thus in a simple operation, such as the removal of adenoids, the patient is brought thoroughly under ether (preceded, if possible, by nitrous oxide), he is then raised into a sitting position with the head bent forward (a position quite unsafe with chloroform), and the mouth being opened with a gag, the operator is allowed to have free access to the naso-pharynx. Thus the blood and detached growths readily escape through the nose and mouth, and respiration is not dangerously interfered with. In a graver operation—*e.g.*, removal of the tongue or jaw—ether should be administered for fully ten minutes or a quarter of an hour, till the patient is brought deeply under its influence. The patient is then carefully propped up with pillows, and the operation completed as rapidly as possible. Prolonged administration of ether at first is especially called for when any preliminaries—*e.g.*, laryngotomy, passing a ligature through the tongue—precede the operation itself. If the above mode of administration* does not give sufficiently prolonged anæsthesia, this may be further kept up by an ingenious plan of my friend Dr. F. G. Hewitt. He utilizes his modification of Mason's gag for administration without getting in the way of the operator—a very frequent source of trouble in these critical cases; thus, under one of the arms of the gag is soldered a fine tube, to this tubing is attached, and by this means the administrator, not now in the way, can prolong the anæsthesia by means of chloroform diluted with alcohol, thus sent direct into the mouth by a Junker's apparatus.

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* I have spoken here of the danger which accompanies anæsthetics in these cases.

† Dr. Crombie (*Pract.*, vol. xxxv. p. 407) considers that the injection of morphia preliminary to the administration of chloroform greatly diminishes the amount of chloroform required, and lessens the risk of cardiac syncope and asphyxia.

LOCAL ANÆSTHESIA.—*Cocaine.*—The value of this drug in the minor operations of surgery has been abundantly confirmed, while at the same time ample proof has been given that it is not without its dangers. It may be used in three ways: (1) by hypodermic injection; (2) instillation; (3) by painting over cutaneous or mucous surfaces with a strong solution. The following are amongst the operations in which it has proved most serviceable:—Opening abscesses, removal of sebaceous cysts, operation for ingrowing toe-nail, circumcision, removal of nasal and aural polypi. Amongst severer and more doubtful cases cocaine has been employed in operations for anal fistula, hæmorrhoids, recurrent nodules of scirrhus, adenomata of the breast, and the operation for strangulated hernia (p. 641). The use of cocaine is especially indicated in cases where the surgeon cannot obtain sufficient skilled assistance, where such a condition as heart disease renders the administration of anæsthetics unadvisable, and where the extent of insensibility required is certain to be localized, and not very deep.

To give a few instances: In the case of a sebaceous cyst, the parts being prepared by shaving, &c., the surface is well painted with a 20 per cent. solution, and after five minutes an injection is made of 3 or 4 minims of a 4 per cent. solution at two or three spots, according to the size of the cyst, around the cyst. After the injections five minutes must elapse before the operation is proceeded with. In ingrowing toe-nail the drug is used in the same way; as soon as the parts are insensitive to the prick of a scalpel, the soft parts on the inner side of the nail are transfixed by a narrow sharp bistoury entered at the posterior and inner angle of the nail and thrust through on to the plantar aspect; the operator then cutting forwards, all the soft parts on the inner aspect of the nail are entirely removed. As this is done, an assistant may drop on a few drops of a 12 per cent. solution, or apply it with a camel's-hair brush.* For a circumcision both aspects of the prepuce should be well painted with a solution of 12 per cent. If this, in five minutes' time, is not sufficient, two or three injections (3 minims) of a 4 per cent. solution should be made at points in the prepuce close to its attachment to the corona. For a fistula a plug of cotton-wool soaked in a 20 per cent. solution should be carefully inserted with a probe for ten minutes previous to the operation. For hæmorrhoids the mucous membrane and piles should be thoroughly painted with a 20 per cent. solution, and then each pile injected with 1 minim of a solution of 4 per cent. For removal of nasal and aural polypi and the uvula, repeated painting with a 20 per cent. solution, applied with a camel's-hair brush or a probe tipped with cotton-wool, is sufficient. The same will deaden, though it does not entirely remove, the pain of removal of a tonsil.

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* This operation is far more efficient than evulsion of the nail, for it attacks the soft parts, which, and not the nail itself, are at fault.

The following points must always be carefully remembered:—(1) Cocaine may be poisonous, even deadly; it has caused dangerous symptoms in doses which have been thought safe. The dangers are greatest when it is injected subcutaneously, and when in addition it is applied to the wound during the operation by instillation or by a camel's-hair brush. The dangerous symptoms which have been repeatedly noticed are: Syncope, with intermittent pulse, profuse sweating, loss of power in the limbs, giddiness, inability to articulate. It is probable that some patients are especially liable to these effects; cocaine must always be used with much caution in children under five. (2) Subcutaneous injection should always be multiple, and in small doses—viz., two or three injections of 3 or 4 minims of a 4 per cent. solution scattered about the area of operation—and never take the form of a single large injection. The use of a piece of drainage-tube, as a tourniquet, whenever practicable, as in circumcision, prevents the diffusion of the drug, and thus increases its action. (3) In deciding whether to use cocaine, the length of the operation, the sensitiveness of the parts, the ability of the patient to bear even mitigated pain, must all be taken into account, in addition to those points which always seem to justify a trial of cocaine—viz., the single-handedness of the operator, the presence of heart disease, or any unusual dread of general anæsthesia, and the absence of skilled administration, or of safer anæsthetics, such as ether or A.C.E. Finally, certain unknown quantities must always be allowed for—viz., the possible presence of adhesions, as in a small adenoma, which appears encapsuled and quite simple, the branching of a fistula which appears single, the importance and risk of struggling, &c. (4) Solutions of cocaine—and I have here been speaking of the hydrochlorate salt—are liable to decomposition. This may be prevented by the following combination (Glück, *New York Med. Record*, 1890):—Phenol ♏ij, cocaine hydrochlorate gr. x, aq. dest. ʒj.

Freezing of the Skin by Ether.—I mention this only to condemn it. The frozen skin is so altered to the knife that the operator is seriously embarrassed. Pain is by no means abolished.* Thickened and somewhat cheloid scars persist afterwards for some time.

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* I can speak here from an *experimentum in corpore vili*, having had, seventeen years ago, seven incisions made for palmar suppuration by this method.

HINTS ON ANTISEPTIC TREATMENT.

No attempt will be made here to give a full account of the antiseptic method. I have only space to give, and that too disjointedly, some of the practical points which have been impressed upon me during the last twenty years. My remarks will fall under the following heads:—A. Aphorisms. B. The most useful antiseptic materials. C. An antiseptic operation and the chief things needed.

A. Aphorisms.—(1) *No perfect antiseptic is known as yet.*—Those that are strong enough to be reliable are at times even poisonous and always irritating. Thus the antiseptics used must be as limited in amount and as diluted in strength as is consistent with safety. Even then much sero-sanguineous effusion, calling for careful drainage, is almost certain. An antiseptic that is reliable, one that will not irritate, and is not liable to poison, is as yet unknown. (2) *No use of antiseptics, however elaborate, is, per se, sufficient to secure success.*—The surgeon must rely on himself, and on general surgical principles as well, and must give as unremitting attention to details as ever.

B. The Most Useful Antiseptic Materials.—i. *Carbolic Acid.*—This, the first antiseptic employed by Sir J. Lister, still maintains its place as in many ways the best. It exists in two forms, the impure commercial acid, and the pure form or absolute phenol. The latter, less irritating and less strong-smelling, but somewhat more expensive, should alone be employed. *Carbolic Lotions.*—These are of two strengths, the 1 in 20 and the 1 in 40. Both should be clear, otherwise they are impure and irritating to the skin and, *à fortiori*, to the recently cut tissues. The 1 in 20 is used for washing the patient's skin, the hands of the surgeon, and in former times for the spray. It has been largely replaced here by the use of 1 in 1000 or 1 in 2000 hyd. perch. solution, and is needlessly strong and irritating. The 1 in 40 solution is practically strong enough for washing the skin (if preceded by plenty of soap, and ether if needful), for keeping sponges and instruments in, for washing out the former during an operation, and for irrigation if carbolic acid be employed for this purpose. *Carbolic Oil.*—This is also used in two strengths, 1 in 10 and 1 in 20. The former is only needed when carbolic acid is being used as a dressing to foul wounds, or to those near the anus, &c. The latter is used for saturating gauze or lint dressings, for use especially when it is desirable to get plugs painlessly out of a deep wound, and for lubricating catheters, &c. *Carbolic Gauze.*—This is fine tarlatan or book muslin, impregnated with carbolic acid (1 part), resin (4 parts) to retain the volatile carbolic acid, and paraffin (4 parts) to prevent the layers of gauze sticking together or to the skin. Gauze dressings are divided into deep and superficial. The deep are the smaller, cut so as to widely overlap the wound and green protective in every direction; the superficial being larger and overlapping the deep in the same way. The number of layers must depend on the size of the wound and probable amount of discharge, the length of time that the first dressing is to be left undisturbed, and also whether gauze or white bandages are used. As the gauze may contain septic germs, and as it gives off carbolic acid but slowly, the deep dressing (usually six or eight layers) is wrung out of carbolic acid lotion (1 in 40) or carbolic oil (1 in 20). To prevent the discharges soaking out, and thus allowing germs outside to set up putrefaction in the outer layers, and so gradually to reach the wound, it is usual to place a piece of mackintosh cloth, with the rubber side downward, within the outermost layer, usually the sixth or eighth. At p. 1096 I have given my reasons for much preferring dry dressings, and need not repeat them here. *Harmful effects of carbolic acid.*—(*a*) *Carbolic acid poisoning.*—This may be acute or chronic. In the former, collapse, low temperature, feeble pulse, respiration, and drowsiness form the chief evidence; in the latter, nausea, vomiting, drowsiness, and a varying amount of collapse are present. In both acute and chronic carbolic acid poisoning, the urine is often dark-green in colour, diminished in quantity, and often albuminous. (*b*) *Erythema and eczema* are sometimes caused by the use of carbolic acid, especially when the skin is delicate and rugous, as in the scrotum. While the above troubles are in some cases due to prolonged use of the acid, in others to a thin skin, in a third group to impurities in the acid, there is no doubt, as pointed out by Mr. Cheyne (*Antiseptic Surgery*, p. 592), that there is another explanation, and that is a certain amount of fermentation due to micrococci. Thus it comes about that the excoriation and eczema are accompanied by a sour smell, and that they occur in cases where the dressing has been left on many days. Where it is desired to continue the carbolic acid, the above troubles may be mitigated by the use of salicylic cream (p. xxvii).

ii. *Mercury Perchloride.*—This most effectual antiseptic has largely replaced carbolic acid of late years. It is used as a lotion, and as a gauze. In either case the mercury salt should be combined with chloride of ammonium (sal alembroth), as by itself it forms with albumin an insoluble and inert compound. A solution of 1 in 1000 is sufficient for irrigation and cleansing the skin (previously washed with soap, and, where sebaceous material is abundant, ether), for cleansing sponges, and for dipping the hands in during an operation. Extremely convenient and portable tablets of mercury bichloride are now readily obtained. Sal alembroth gauze has the great advantages of being extremely soft, and, from its blue colour, readily showing how far the discharges have soaked through. Where expense is an object, all the part that keeps its colour may be retained and cut up into strips for other dressings. The gauze should be used dry. *Harmful effects of mercury perchloride.*—(1) *Vomiting, diarrhœa, and fatal collapse* have been known to follow where over-strong solutions have been used, or where much solution has been left behind, and so absorption favoured. (2) *Irritation and eczema* have been described as not infrequent. After a very large experience with this germicide for six years, I have never seen a case of the first drawback, and only one of the second—viz., in a delicate girl, from the back of whose wrist a large ganglion had been removed. Here the local trouble did not occur for ten days, and as she was treated as an outpatient, and as the dressings had not been disturbed for three days, I believe the real cause was fermentation and micrococci (p. xxv). (3) *It ruins all steel instruments.*

iii. *Creolin.*—This antiseptic, prepared by distillation of coal, has not found favour widely amongst English surgeons. It is certainly a good antiseptic, and a less poisonous one than carbolic acid and corrosive sublimate; but the fact that it is insoluble in water, that the emulsion that it forms with water is opaque, and obscures parts operated on when it is used in irrigation, and also instruments placed in it for sterilization, while it also renders them slippery to handle, are powerful objections to it. It has been recommended as a useful medium for washing the hands, as it does not benumb them like carbolic acid, or roughen them like corrosive sublimate and carbolic acid. In my opinion, it is undesirable to further complicate the number of our antiseptics. We must still wait for one that is without drawbacks. Carbolic acid and corrosive sublimate have certainly a far wider range of applicability, and are thus more useful than creolin. While they have undoubted drawbacks, these can be met by care in using them.

iv. *Boracic Acid.*—This is non-poisonous and quite unirritating, but its antiseptic powers are feeble. Thus it is especially indicated, when wounds are superficial, as an ointment or as boracic acid lint or green protective soaked in the saturated solution. But in large wounds, where foul pus has been let out, or where much swelling is expected, boracic acid may be used with the very best results, if only the feeble antiseptic is frequently renewed. For this purpose two thicknesses of boracic acid lint (ordinary lint dried after it has been soaked in a saturated solution of the lotion) are wrung out of the lotion, and placed in the wound, a few drops of the lotion being trickled on to the lint every half-hour, the lint itself being removed every two or three hours. Boracic acid ointment is best made with salicylic acid crystals and vaseline.

v. *Iodoform.*—While the germicide* power of this drug is still disputed, there is no doubt as to its value. Whether it attacks directly microbes or ptomaines, whether it only acts indirectly by drying up the secretions of the wound, there is no doubt that iodoform, though by no means a powerful germicide, has a marked effect in preventing putrefaction. It is especially useful when very finely powdered and mixed with boracic acid powder, and carefully dusted in small quantity into the crevices of a wound, just before this is closed. It may also be used with collodion, or with ether (1 in 8), in operations about the mouth, lips, jaws, vagina, rectum. Iodoform gauze has all the softness and pliability of sal alembroth gauze, but is much more expensive. The great objection to iodoform, its smell, considered tell-tale from the original association of this drug with soft chancres, has not yet been satisfactorily met. I have tried the following, but my experience is that, however skilfully the chemist disguises, at first, the disagreeable odour of this drug, it is apt to betray itself later, as the more volatile scent disappears. Oil of sanitas ʒss, iodoform ʒss, vaseline ℥j has been recommended by Mr. Hutchinson. If it be desired to disguise the odour of iodoform in powder, Tonquin bean, balsam of Tolu, oil of peppermint may be added, but the success will be only partial. The addition of finely powdered coffee, freshly roasted, is somewhat more successful. Iodol, with finely powdered boracic acid, is a good substitute, but is more expensive, and, in my experience, sometimes fails altogether. It is not only odourless, but devoid of poisonous properties. *Harmful effects of iodoform.*—In some cases delirium, stupor, an irregular temperature, nausea, vomiting have been noticed. These poisonous effects are especially to be dreaded when iodoform is used over a very large surface in a weakly patient, in a cavity where it is retained, or in cases where it is used in crystals, which are not readily removed, or in excessive amounts.

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* As pointed out in Holmes' *Treatise on Surgery*, p. 35, it is possible that those who on experimental grounds have denied the germicide power of iodoform, have overlooked the fallacy that the experimental mixture was not maintained at the temperature of the body. When this is done, the micrococci of pus in the

The influence of iodoform upon other than septic germs must be alluded to. The question of its anti-tubercular action still remains open. In Germany an emulsion of iodoform and glycerine has been largely used in cold abscesses. From my experience in three cases of spinal abscess, this use of the drug is futile, the abscess remaining quiescent, and, when laid open many weeks after, being found to contain a greenish treacly fluid with altered pus.

vi. *Salicylic Acid.*—This is used, in this country, chiefly as a wool or as a cream. The former is prepared with 3 or 10 per cent. by weight of the acid, glycerine being added to make the crystals stick better to the wool. It is an elastic and reliable dressing, but its irritating effect upon the respiratory passages is well known. I therefore much prefer the sal-alembroth wool. Salicylic acid cream, made by mixing the crystals with glycerine and carbolic acid (1 in 10 of these) so as to form a paste, is a very valuable application where a dressing has to be left on

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presence of moisture have the power of decomposing iodoform and setting iodine free; it thus may act as a powerful germicide.

some days, and where irritation and eczema have followed on the use of carbolic acid, &c. (p. xxv).

vii. *Eucalyptus Oil.*—This, when used as a substitute for other antiseptics—*e.g.*, carbolic acid or mercury perchloride—has been found untrustworthy. It is useful as an ointment in rectal and vaginal examinations.

viii. *Thymol.*—This also is unreliable as a germicide and antiseptic. It may be employed in wounds that are granulating healthily, where the smell of carbolic acid is objected to. For all important cases it should be abandoned.

ix. *Zinc Chloride.*—This has been used in septic sinuses and foul ulcers as a lotion (gr. xl–℥j), or in operations about the jaws, anus, &c. Care should be taken, when it is injected into sinuses, not to use it stronger than half the strength given above, and to provide a very free exit, otherwise fatal sloughing and gangrene may follow on the use of this powerful remedy.

I have alluded above to the gauzes, carbolic acid, sal-alembroth, and iodoform. Some other dressings must be mentioned here. *Wood-wool Dressings.*—I tried this largely some years ago, and found it cheap and efficient as an outer dressing—*i.e.*, over a deeper one of sal-alembroth gauze. From its liability, however, to get into knots and lumps, it is not easy to secure well-adjusted compression, fitting well over uneven surfaces, with this dressing. *Jute and Tow.*—These have the advantage of cheapness, and have been largely used on the Continent as pads. If, however, these are dry, their absorbent power is insufficient to take up secretions perfectly; if used wet, they are liable to irritate. If employed, they need changing frequently. Carbolized tow is a useful dressing over the anus after operations for hernia, varicocele, &c.

Green Protective.—This is thin oil silk varnished with copal, and coated with a layer of dextrine. The object of the protective is to keep a young and tender wound from the irritating effects of antiseptics—*e.g.*, carbolic acid. For this purpose the copal, which is impermeable to carbolic acid, is added. But as the copal prevents the protective from being uniformly, and therefore safely, wetted with the antiseptic lotion in which it is immersed before it is placed on the wound, dextrine is added. The protective should only be cut a little larger than the wound. I find it especially valuable in such cases as extensive removal of the breast, where it is impossible to close the whole wound, and a portion of the pectoral muscle is left uncovered. Here the protective prevents irritation of the vascular muscle, and so diminishes the sero-sanguineous oozing, while it prevents the dressing sticking to a raw surface. Whenever it is used, it must be soaked in solution of carbolic acid or perchloride, and no more used than is necessary to cover the wound, for it must always be looked on as an additional complication, and, without the above precautions, an additional risk of the entrance of germs.

Drainage and Drainage-tubes.—These are points of cardinal importance in aseptic wounds, from the fact that all reliable antiseptics are more or less irritant to the newly cut tissues. Thus, if the sero-sanguineous oozing which is formed for the forty-eight hours has not a free exit, tension, inflammation, and suppuration (the pus being abundant, though sweet) are certain. The question of when to drain and when to dispense with drainage is not to be answered by any hard-and-fast rules: the following are the chief points to be considered:—(1) *What is the condition of the wound or cavity? is it septic or aseptic?* If it be septic, its walls cannot be relied upon to absorb. (2) *What amount of sero-sanguineous oozing must be expected?* Where this is likely to be large, as where large muscular surfaces have been cut obliquely, as in making transfixion flaps (p. 47), free drainage must be provided. Other sources of this sero-sanguineous oozing are over-strong antiseptic lotions, leaving these behind in the wound instead of squeezing them out and leaving the wound dry. Finally, leaving vessels untied need only be alluded to. (3) *What is the size of the cavity, and how far is it a single and simple one?* (4) *How far can pressure be trusted to for the obliteration of any wound cavity?* Where, in an aseptic wound, where all hæmorrhage has been stopped, firm and even pressure can be applied, drainage-tubes can be largely dispensed with, and primary union thus rendered more probable. But in many cases—*e.g.*, where the above conditions cannot be secured, or in a region like the neck—drainage must be resorted to. And in all doubtful cases drainage must be the rule. For if retained discharges or retained hæmorrhage are not aseptic, there is a much greater risk of blood poisoning.

Drainage is secured by different means—*e.g.*, tubes of rubber or glass, horsehair, and catgut. Glass tubes (Keith's tubes) are used for drainage of the peritonæal cavity (p. 872) where it is considered unadvisable to close this for fear of septic products being left behind. The tubes usually employed are those of red india-rubber, with holes cut in them at intervals. When inserted, the tube must not project beyond the surface, or its opening will be doubled over by the dressings, and the exit of discharges prevented. Loops of carbolized silk should be inserted at the orifices of the tube to prevent its slipping in, and to facilitate syringing through it. In a large wound it is well to use two tubes, and one smaller than the other. Thus, after removal of a large breast and clearing out the axilla, a tube of larger size should be passed from end to end of the wound, and a smaller one at the outer end up into the axilla. Thus the second can be retained after the first is removed.

Mr. Cheyne (*Antiseptic Surgery*, p. 78) has pointed out the need, in certain cases, of bringing out the drainage-tube, not at the most dependent part, where this will be close to sources of sepsis—*i.e.*, fæces, urine, or menstrual fluid—but at the end of the wound which is most remote from these.

No definite rules can be given for the date of removing tubes; we must here be guided by the same principles by which we decide whether to use drainage at all (p. xxix).

Drainage by capillarity, which we owe to Prof. Chiene, is best carried on by a bundle of horsehair, which has been first carefully cleansed and kept in a solution of carbolic acid (1 in 20). This method is only adapted to small wounds—*e.g.*, femoral hernia—or when used in combination with tubes.

Ligatures.—These are of chromic catgut and silk. The former will suffice for the great majority of cases. It should be procured from a reliable maker, and keeping it dry in hanks is much more convenient than the different holders and troughs sold for keeping it in carbolic oil. The dry gut needs soaking in *hot* (1 in 20) carbolic acid lotion for a few minutes before it is used. With regard to silk ligatures, I have spoken at p. 457 of the need of using only Chinese twist silk, and not the plaited form. At p. 540 the use of other forms of ligature—viz., ox aorta and kangaroo tail—is discussed.

Sutures.—Of the many forms there are three which will be found the best—viz., salmon-fishing gut, silver wire, and horsehair. The first two have the great advantages of being very readily carried about, very easily rendered safely aseptic, the salmon gut by steeping it in *hot* carbolic solution (1 in 40) for a quarter of an hour before it is used, and the wire by passing through a clean towel and then placing it in the above solution. Wire has also the advantage of being inserted and twisted very rapidly. Horsehair, prepared as above, supplies very fine sutures. It is non-absorbable, and thus can be left in after stouter sutures have been removed, while its smooth epithelial surface and tough elastic properties make it very easy of application. Catgut sutures, owing to their tendency to soften, should only be used when buried sutures are needed, as in uniting cut muscle to muscle—*e.g.*, after ligature of the external iliac or removal of a femoral exostosis. It is also useful in circumcisions.

C. AN ANTISEPTIC OPERATION CONSIDERED GENERALLY.—*The Room.*—In an operation of any importance in a private house the hygienic antecedents should be carefully inquired into. A spare bedroom, if large enough, makes the safest operating-room if prepared as follows:—Superfluous furniture, carpets, &c., being removed, the room is well dusted, and scrubbed and washed. The windows are then left open for one or two days and nights. On the evening before the operation everything that will be required save the instruments—*i.e.*, necessary chairs and tables, bedding, towels—are brought in to be disinfected. All the doors and windows are carefully closed, it being arranged that one of the latter can be opened from the outside in order to let the fumes out before the room is entered. A large basin or pan is then filled with sand, and on this is placed a small iron cup or pan containing sulphur in small pieces (1 oz. to each cubic yard in the room), and a little wood for burning. This is lighted the evening before the operation, and the room kept closed till the following morning, when the window is opened, and the room entered later. The patient is prepared, if possible, by daily soap-and-water baths; the day before the operation the part to be operated on is cleansed with soap and nail-brush, ether, or spirits of turpentine, and then a compress of 1 in 2000 hyd. perch. solution is bandaged on.

An operation-table may be readily improvised by three dressing-tables, two side by side, and one across them at the head. Where much shock may follow, as in all abdominal operations, a water-bed filled with hot water should be employed.

The following list of the things required may be convenient:—4 pints of carbolic lotion, 1 in 20. This can be quickly diluted. The same amount of 1 in 1000 solution of hyd. perch. Thoroughly reliable sponges which, if used before, have been cleansed as directed below, and have been kept in a 1 in 20 solution of carbolic acid, and which will be washed in a 1 in 40 solution during the operation. Two or three scrupulously clean pie-dishes, filled with a 1 in 40 carbolic acid solution, to contain the instruments. Two or three smaller dishes—sponge basins, pudding basins, or toothbrush trays will do quite well, but should be scalded out first—filled with the same solution to hold chromic gut ligatures and sutures, the former being always kept separate to ensure prompt handling. In another small basin a solution of hyd. perch., 1 in 2000, for irrigation with lint, should be at hand; while in one more, a solution of 1 in 1000 should be ready for the operator and his assistants to dip their hands into during the operation. Drainage-tubes of different sizes; horsehair drains: sutures, and of these salmon gut and silver wire are on the whole the best; a guard of carbolized lint to throw over the wound at any pause in the operation; towels wrung out of 1 in 40 carbolic acid; mackintoshes, a syringe, dressings, safety pins, should all be at hand. The surgeon should see that his hands and those of his assistants should be scrupulously clean, especially about the nails.

I have no space to describe an aseptic operation in detail, and I trust that the fulness with which I have endeavoured to give the details of the different operations later renders this needless. I will merely enumerate the different steps which a surgeon must keep before him at every operation. They are: (1) Rendering the parts to be operated on aseptic; (2) keeping his wound aseptic by irrigation, the fluid used being not too strong—*e.g.*, mercury perchloride, 1 in 2000 during the operation and 1 in 5000 while the sutures are inserted, and not used in excess, but only in a few drops at regular intervals; (3) taking care that everything which comes near the wound is aseptic, by seeing that the instruments and sponges* only come out of lotion or off a carbolized towel, and that his fingers and those of an assistant are from time to time dipped in a 1 in 2000 mercury perchloride solution; (4) arresting all hæmorrhage; (5) providing sufficient drainage; (6) suturing the wound carefully, but not too tightly; (7) applying the dressings carefully and with sufficient pressure.*

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* Sponges should be wrung out of carbolic acid solution (1 in 40) or out of

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mercury perchloride (1 in 2000) during an operation. Afterwards they are cleansed in warm water frequently, containing a weak solution of common soda; next they may be steeped in the liq. sod. chlorin. (B.P.) diluted with equal parts of warm water, or sulphurous acid lotion (1 part of the acid to 15 of the water), and finally kept in carbolic acid solution (1 in 20).

* Instruments after use should be cleansed in warm water with a toothbrush to remove all blood, &c. They are then, for sterilization, placed in boiling water, after which they are very carefully rubbed dry.

PART I.

OPERATIONS ON THE UPPER EXTREMITY.

CHAPTER I.

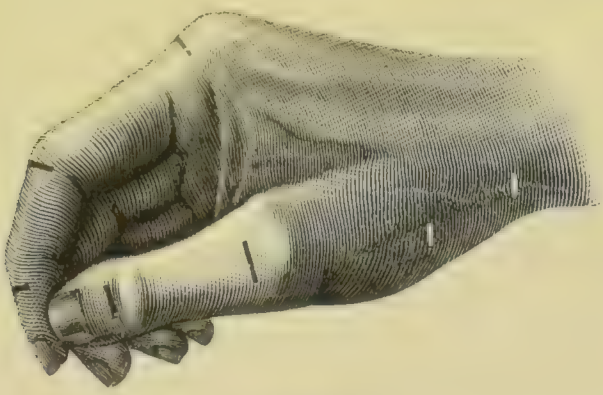
OPERATIONS ON THE HAND.

AMPUTATION OF FINGERS.

Practical Anatomical Points.—I. Position of Joints (Fig. 1).—This has to be remembered—(α) in front, (β) behind.

(α) *In Front.*—Three sets of creases correspond here, though not exactly to the joints. Of these, the lowest crease is just above the joint; the middle is opposite to the inter-phalangeal joint; the highest, nearly $\frac{3}{4}$ inch below the metacarpo-phalangeal joint.

Fig. 1.



(Dubreuil.)

(β) *Behind.*—It is to be remembered here (1) that in each case it is the upper bone which forms the prominence—viz., the knuckle is formed by the head of the metacarpal bone, the inter-phalangeal prominence by the head of the first phalanx, and the distal one by the head of the second; (2) that the joint in each case lies below the prominence, the distal joint being $\frac{1}{12}$ inch, the inter-phalangeal $\frac{1}{6}$ inch, and the metacarpo-phalangeal joint about $\frac{1}{3}$ inch below.*

II. Shape of Joints.—In the distal and the inter-phalangeal the joint is concave from side to side, and presents a concavity towards the tips; in the metacarpo-phalangeal joint, on the other hand, the convexity is towards the finger-tips.

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* The terms "above" and "below" mean nearer and farther from the trunk.

III. THE THECA.—This fibrous tunnel running down to the bases of the distal phalanges and upwards to the palm gapes widely after section. From the readiness with which the tendons conduct sepsis into the forearm itself, care should be taken to keep even such a small amputation as that of a finger strictly sweet, and, in amputating through damaged parts, the flaps should not be too closely united with sutures.

Operations for Amputation of Fingers.—As one fixed method is rarely available, and as the rule here to remove as little as possible is unalterable, several should be practised, including among them the following four—viz.:

1. Long palmar flap (Figs. 2, 3, and 4).
2. Long dorsal flap.
3. Two equal antero-posterior flaps.
4. Two lateral flaps (Fig. 5).

Of these, the palmar flap is usually the one made use of. Though, as the hands are by far most frequently placed in the prone position, a dorsal flap falls more easily into place, and gives a more concealed scar, a palmar flap has the greater advantages of not being pressed upon when anything is held in the hand, of possessing finer sensitiveness in touch and better nutrition; furthermore, this flap is available even in the last phalanx, where, from the presence of the nail, a dorsal flap is not obtainable (Fig. 2).

Amputation of Distal Phalanx by Palmar Flap (Fig. 2).—**First Method.**—The hand being pronated, a strip of lint wound round the phalanx to give a firm grip,* and the adjacent fingers well flexed, the surgeon, having placed his left fore-finger just below and behind the joint, and flexed the phalanx strongly with his thumb (a step not always easy with infiltrated tissues), cuts,† with a slightly semilunar sweep, straight into the joint. To effect this neatly, the convexity of the sweep should pass $\frac{1}{12}$ inch below the prominence or angle produced by flexion, the sweep being made by laying on the whole edge of the knife, while with the point, as this incision begins and ends, the lateral ligaments are partly cut. The joint being thus freely opened, the knife is insinuated behind the base of the phalanx (a step which is facilitated by depressing and pulling on the phalanx), and then, being kept close to, and parallel with, the bone, cuts, with a steady sawing movement, a flap well rounded at its extremity, about two-thirds in length of the pulp of the finger.†

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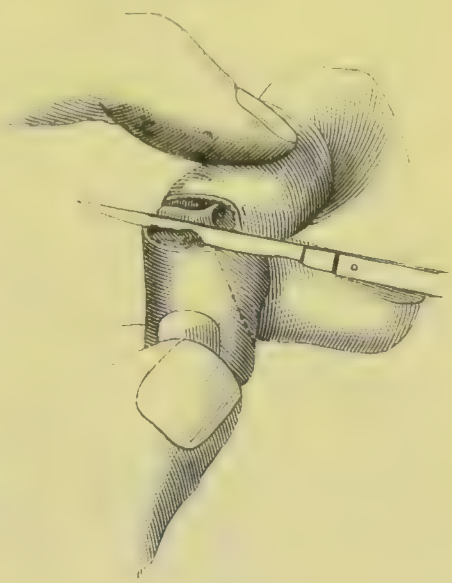
* In the drawing this is left out for the sake of distinctness.

† The knife in all these finger amputations should be narrow, short, slender yet strong.

FIG. 2.*



Second Method.—The hand being supinated, the finger to be operated on extended, and the others flexed out of the way, a palmar flap is cut by transfixion, the knife being entered just below the palmar crease, the joint being then opened from the dorsum as before, and the phalanx lastly disarticulated.

Third Method.—If the surgeon has no narrow knife by him, he may modify the last method by cutting his palmar flap first, but from without inwards; he then opens the joint from the dorsum, and disarticulates.

As a rule, no vessels require ligature. Any tendon that is ragged should be cut square.

Difficulties and Mistakes in Amputation of Distal Phalanx.—The flap may, of course, be made too short; it is often made too pointed. If the phalanx be not sufficiently flexed, or if the site of the joint has not first been marked out with the nail, the latter will not be readily opened, the knife sawing against the neck of the second phalanx. It is often difficult to pass the knife easily behind the base of the phalanx, especially in cases where the blade is too broad, or where, as in well-developed hands, the base of the phalanx is strongly tuberculated. If there be any considerable hitch in passing the knife behind the phalanx, the base of the flap is very likely to be jagged.

Amputation of Second Phalanx.—This, as a rule, should be performed through the phalanx, and, wherever this is possible, beyond its centre, so as to leave the upper half or third of the phalanx, and thus ensure some attachment of the flexor being preserved.

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[*] The palmar flap here is made somewhat too short, sharp, and wedge-shaped.

[†] If the flap is insufficient, the head of the second phalanx must be removed.

While the rule not to amputate a finger at the joint between the first and second phalanges, and *a fortiori* through the first phalanx, is a sound one, as there is a risk of leaving a stump stiff and incapable of flexion, there is no doubt whatever that at times the above amputation has been followed by the flexor tendon taking on a fresh and sufficiently firm adhesion, and so leaving a longer and, withal, a mobile stump.

In the following special cases the whole or part of the first phalanx may be left, and in all of them the severed flexor tendons should be carefully stitched with carbolized silk to the cut theca and periosteum, or into the flaps before these are adjusted.

1. In the case of the index finger the proximal phalanx will be a useful opponent to the thumb, as in holding a pen.

2. In the case of the little finger, leaving the proximal phalanx will give greater symmetry to the hand when this is flexed, and it should accordingly be left, if the patient desire it (Fig. 8).

3. In cases of amputation of all the fingers, the proximal phalanx of one should, if possible, always be left to oppose to the thumb.

4. In the case of a patient who insists on having the proximal phalanx left, after the risk of stiffness has been explained to him. The more care is taken to fix the severed flexors to the theca, the more quickly the stump heals, and the younger the patient, the greater will be the movement gained.

Dr. Tiffany, of Baltimore (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 826), says that he has been in the habit "for a number of years" of passing the stitches which unite the skin through the tendons and their sheaths in amputation at the joint between the first and second phalanges. "I have never failed, as far as I can remember, to secure quite as good movement as if Nature had originally made an attachment there for these tendons."

Amputation through Middle Phalanx.

(1) **By a Long Palmar Flap** (Fig. 3), or **by Dorso-palmar Flaps**, the flaps being equal, or the palmar one the longer (Fig. 5).

By Dorso-palmar Flaps.—The surgeon, marking with his left fore-finger and thumb* where he intends to divide the bone, cuts between these points a short, well-rounded dorsal flap of skin; he then sends his knife across below the bone, making it enter and emerge at the base of the first flap, and cuts a palmar flap about $\frac{2}{3}$ inch in length, and not pointed. The flaps are then retracted, the bone cleared with a circular sweep of the knife, and divided in the manner given below.

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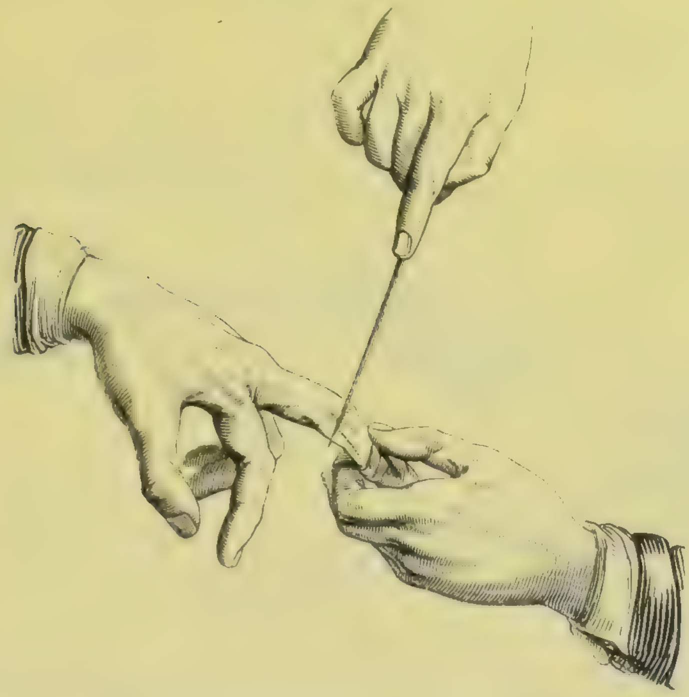
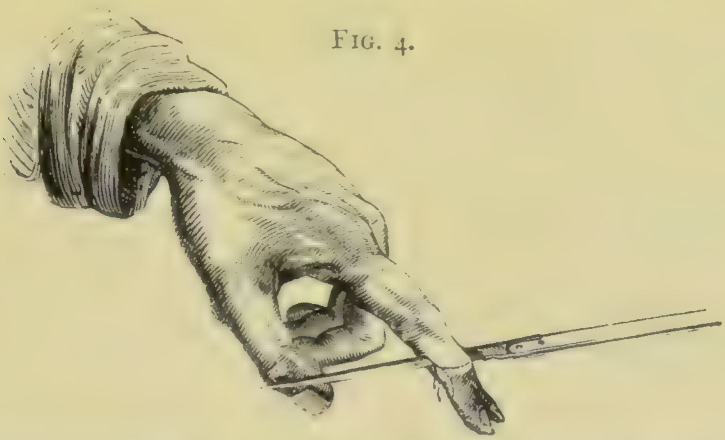
* These are left out in the drawings for the sake of distinctness.

FIG. 3.



Amputation through inter-phalangeal joint by long palmar flap, the joint being opened first. (Fergusson.)

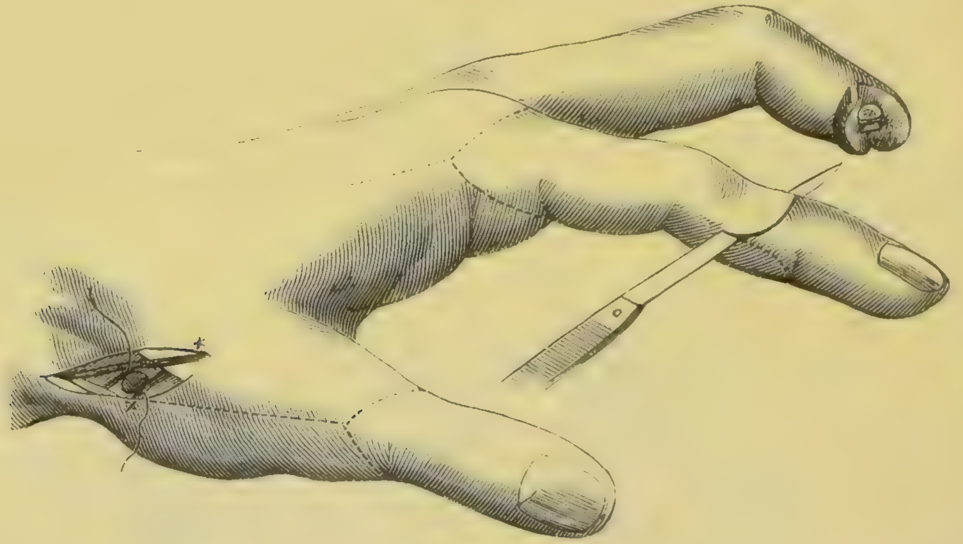
FIG. 4.



Amputation through second phalanx by long palmar flap, this being made first by transfixion. (Fergusson.)

By Lateral Flaps (Fig. 5).—The site where the bone is to be sawn being marked by the left forefinger and thumb placed on the dorsal and palmar aspects of the finger at this level, the surgeon, looking over the finger, enters his knife in the centre of the palmar aspect, and carries it, cutting an oval flap, about ½ inch in length, to a corresponding point on the centre of the dorsum, and then from this point down again over the side of the finger nearest to him, to the point where the knife was first entered. The flaps being dissected up as thick as possible, and the remaining soft parts severed with a circular sweep, the bone is divided with saw or bone-forceps. If necessary, one flap can be cut longer than the other. In using the bone-forceps the concave surface is always to be turned away from the trunk; if this precaution is taken, and the bones severed quickly, the section will be clean, and not crushed. But a fine saw is the safer instrument.

FIG. 5



In the second finger, amputation through the second phalanx by lateral flaps is shown. The bone has been divided below the insertion of the flexor sublimis; if there were any doubt about this, the tendon would be stitched to the theca and flaps, as advised at p. 4. In the index finger, amputation through the second phalanx by short dorsal and long palmar flaps is figured. The left finger and thumb of the surgeon, which would mark the base of the flaps, are left out for the sake of distinctness. The flaps for amputation of the index finger at the metacarpo-phalangeal joint are also shown, the straight part of the incision being placed rather to the radial side of the head of the metacarpal bone.

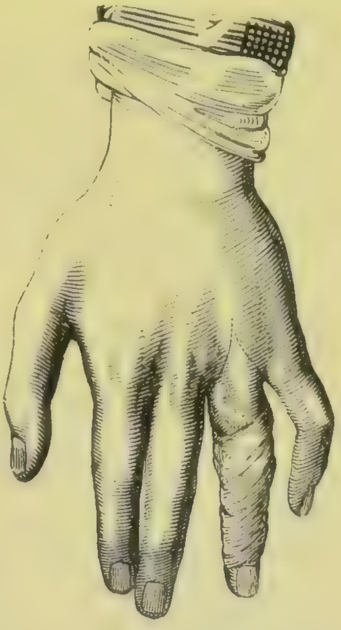
In the thumb, the flaps for amputation at the carpo-metacarpal joint are indicated. The two ** show where the radial artery may be wounded, near the joint, and in the interosseous space, in this amputation (p. 9).

Ligature of the radial artery at the back of the wrist is also represented. The radial vein crosses the wound from angle to angle. The artery, with the ligature under it, is shown between the extensor ossis metacarpi and extensor primi internodii in the lower angle, and the extensor secundi internodii in the upper angle of the wound.

Amputation of Finger, e.g., Second or Third, at Metacarpo-phalangeal Joint (Fig. 6).—This, the most frequently performed amputation on the hand, should be often practised. It is best performed by the modified oval method, the *en raquette* of Malgaigne, or by lateral flaps.

The hand being pronated, the radial and ulnar arteries commanded by an Esmarch's bandage above the wrist, some lint wrapped round the damaged finger, and the adjacent ones flexed out of the way, the point of the knife is entered ¾ inch above the head of the metacarpal bone, sunk down to the bone itself, and then carried down in the middle line till it gets well on to the base of the phalanx; then, diverging to one side, the knife is carried obliquely below the web* across the palmar aspect of the first phalanx below the palm, and then around the other side of the phalanx (also below the web) so as to join the straight part of the incision which lies over the head of the metacarpal bone. In practice, especially in the country, where an anæsthetic is not always easily available, it is much preferable, because quicker, to make two separate incisions, each beginning ¾ inch above the head of the metacarpal bone, and meeting again on the centre of the base of the palmar aspect of the first phalanx, well below the palm, instead of carrying the knife continuously round the finger. This method is not only quicker,† but it does not leave, as in the first method, a small tongue of tissue on the palmar aspect, which is a little difficult to adjust satisfactorily, and behind which discharges may collect.

Fig. 6



Incisions for amputation at metacarpo-phalangeal joint. If the metacarpal bone requires removal as well, the apex of the incision would be prolonged upwards. (Fergusson.)

In either case the knife should be used boldly, the extensor tendon severed in the first incision over the head of the metacarpal bone, and the soft parts at the sides cut to the bone. Then one lip of cut tissue being taken up with finger and thumb, the flaps are dissected up as thickly as possible, tendons cut clean and square, the lateral ligaments severed, and the joint opened by remembering its site well below the projecting knuckle (p. 1, Fig. 1). Disarticulation will be facilitated by twisting the finger, first to one side, and then to the other, so as to render tight the parts which remain to be cut.

Where strength has to be considered rather than appearance, the head of the metacarpal bone should be left, whatever be the rank in life of the patient, as the transverse ligament is thus less interfered with, and the hand less weakened. But where appearance is the most important thing, and the mutilation is to be hidden as much as possible by the approximation of the fingers, the head of the bone should be removed by a narrow-bladed saw or by bone-forceps.* In either case the section should be made obliquely from above downwards and from behind forwards, so as to remove more on the dorsal than the palmar aspect. In such cases, after a little practice, it is not necessary to perform disarticulation, the metacarpal bone being severed after dissecting up the flaps to the proper level. Here, too, care must be scrupulously taken not to interfere with the tissues in the palm.

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* Cutting into the web will lead to much more hæmorrhage, too short flaps unless the head of the bone is removed, and increase of pain in healing.

† Because it avoids the hitch usually met with in carrying the knife around the base of one finger between others.

After removal of the finger and the Esmarch's bandage, one or more digital vessels will require ligature, lying rather deeply opposite the web of the finger.†

In the case of the index (Fig. 5) or little finger, the straight part of the oval incision should be placed to the radial or ulnar side of the metacarpal bone respectively, rather than in the dorsal mid-line, as, in the former case, the line of incision will be concealed between the thumb and second finger, and, in the latter, be less visible in the ordinary pronated position of the hand. In these cases the bone-forceps should be applied obliquely from without inwards and from within outwards respectively, so as to leave no projecting bone on the radial or ulnar aspect of the hand, and, in the former case, to allow of the thumb being readily approximated to the adjacent finger.

It may be worth while to add one hint with regard to the after-treatment, and that is, not to bandage the adjacent fingers too closely or too long together, otherwise a tendency to cross at their points will be noticed later on.

AMPUTATION OF THUMB.

Amputation of Phalanges of Thumb.—Very little need be said about these, as they are very rarely performed. Owing to its numerous muscles, the thumb is extremely mobile, and thus escapes injury. Thanks to its abundant vascular supply, trimming of the soft parts after an injury will generally leave more of the thumb to oppose to the fingers than any set operation.

In cases of necrosis after whitlow, I have twice removed both phalanges, the soft parts consolidating usefully* with the aid of the periosteum that is left. For further remarks on preserving the thumb, see Excision of Thumb, p. 11.

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* With the precautions already given at p. 6.

† Care should be taken to secure these vessels, especially where they are enlarged in any inflammatory condition, otherwise profuse bleeding may take place a few hours after the operation.

Operation.—Amputation of the phalanges of the thumb may be performed, in the case of the distal one, by a long palmar flap, as in the case of a finger (Figs. 2, 3, 4); in the case of the first phalanx, by antero-posterior, lateral, or a modification of the oval method. In any case the incisions should be carried well on to the phalanx to ensure sufficient flaps to cover the head of the metacarpal bone, together with the sesamoid bones, which should never be removed.

The line of the metacarpo-phalangeal joint is very nearly transverse, and lies just in front of the knuckle.

After amputation of either phalanx, the severed end of the long flexor should be carefully stitched into the angle of the flaps and to the theca and periosteum.

Amputation of Thumb at Carpo-metacarpal Joint (Figs. 5 and 7).

Indications.—This operation is rarely called for on the living subject.† Gunshot injuries, enchondromata of phalanges and metacarpal bone (see below, p. 11), epithelioma of a scar, melanotic sarcoma, occasionally call for it.

Operation.—The position of the joint between the trapezium and metacarpal bone, its shape, with two saddle-like articular surfaces fitting into each other "by reciprocal reception," and the position of the radial artery passing over the back of the styloid process just above this joint (Fig. 5), and again, when perforating the first interosseous space, lying close to the metacarpal bone, must be remembered.

The operation is usually performed by the oval method.

An Esmarch's bandage being applied above the wrist, the hand held midway between pronation and supination, and the thumb held rather over-extended so as to relax the parts, the surgeon enters the point of a strong narrow scalpel or bistoury just above the bony tubercle, which usually marks the insertion of the extensor ossis metacarpi pollicis into the base of the metacarpal bone, and carries it along the dorsum of this bone as far as the base of the first phalanx, where it passes (in the case of the left thumb) obliquely to the ulnar side above the web, and then around the palmar aspect of the phalanx, along the radial side, to join the dorsal incision again. Taking up first one edge of the incision and then the other, the surgeon dissects up the soft parts from the bone, keeping the knife-point very close to this, especially on the inner side. The extensor tendons and the short muscles of the thumb being severed, the joint between the trapezium and metacarpal bone is felt for and opened by putting the tissues here on the stretch by twisting the metacarpal bone in different directions.

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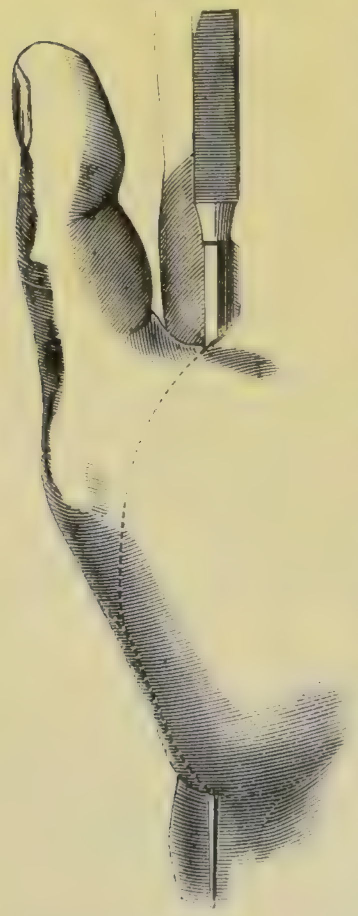
* This is strongly indicated in those cases where it is especially important to leave the thumb long for holding a pen or delicate instrument.

† It is not unfrequently used as an examination test.

Amputation of Thumb at Carpo-metacarpal Joint by Transfixion (Fig. 7).—The hand being held as before, and the parts relaxed by slightly adducting the thumb, an incision is made (in the case of the left thumb) from the base of the metacarpal bone rather to its palmar aspect, along its dorsum, and then obliquely to the ulnar side of the base of the first phalanx; the knife, a long narrow bistoury, is then pushed from this point at the junction of the web with the thumb, across the palmar aspect of the thumb, to the point where the incision started, over the carpo-metacarpal joint. By cutting outwards, along the line indicated in Fig. 7, a flap is formed of the tissues in the ball of the thumb, the knife being kept close to the bone at first, but used more lightly and kept more superficial afterwards, as it comes out through the skin over the sesamoid bones and base of the first phalanx, to avoid being locked here. This flap being held back, the metacarpal bone is dissected out by keeping the knife close to it, the joint opened, and the thumb removed as before.

FIG. 7.



On the right side, it is better to cut the palmar flap by transfixion first, making it enter and emerge just as above given. The blade of the knife is then drawn from the base of the first phalanx obliquely across the dorsum of the metacarpal bone, from one extremity of the transfixion incision to the other. The operation is then completed as before.

EXCISION OF THUMB.

Removal of Phalanges.—Owing to the exceeding value of the thumb, a phalanx should always be preserved if possible, not only in whitlow-necrosis, but in the case of the first or proximal phalanx, when it is the seat of enchondroma. By this, not only is appearance saved by the lessened shortening, but the use of the long flexor, in particular, is preserved. Thus, Mr. Royes Bell (*Lancet*, 1872, vol. ii. p. 846) published a case in which he excised the proximal phalanx in a woman, aged nineteen, for a huge enchondroma of sixteen years' growth, the joints being movable. The phalanx was excised by two lunated incisions over the tumour, the knife kept close to the bone, and the joints opened. No tendons were cut. Eighteen months later the condition of the thumb was excellent, both for all general movements and for writing.

Removal of Metacarpal Bone.—This should always be excised wherever possible, in preference to sacrificing a part of such incalculable value as the thumb. Sir W. Fergusson (*Pract. Surg.*, p. 322), in speaking of this operation, says that he saw it once performed, and, though the organ was far from strong, the patient could use a needle with tolerable facility not long after, and he further remarks that the comparative shortness of the bone removed, and the firm cushion of soft parts that remains after its excision, will make the remaining part useful.

A straight incision, which reaches ¼ inch beyond each extremity of the bone, having been made along the dorsum, the tendons are drawn aside; the distal end and joint are next cleared and opened, when the bone can be used as a lever whilst it is freed from the soft parts on the palmar aspect and then disarticulated. If possible, the periosteum should be preserved.

The radial artery must be remembered both on the ulnar side of the metacarpal bone and by the carpo-metacarpal joint (Fig. 5).

Excision of Metacarpo-phalangeal Joint.—This may be very occasionally required in those cases where a dislocation of the first phalanx cannot be reduced, either as a primary operation or, later on, in a young and healthy patient, to whom the stiffness is a serious drawback.

An incision, 1½ inch long, on the ulnar side will leave least scar; the joint is opened, the bones dislocated, or, if this be found difficult, the ends of the bones may be cleared by keeping the knife-point closely applied to them and by retracting strongly the soft parts; the ends are then removed *in situ* by a narrow saw, which is preferable to bone-forceps. The surgeon should always remove the bones freely, and not content himself with paring off the articular surface, and thus risking the formation of a stiff joint.

EXCISION OF FINGERS.

Only excision of joints need be alluded to here, as, save in the case of removal of the distal phalanx (or the last two in the case of the index) for necrosis, excision of a phalanx leaves a very useless finger.

Excision of an Inter-phalangeal or Metacarpo-phalangeal Joint.—This may be called for after a clean cut into the joint (circular saw, &c.); in the hope of saving one or more damaged fingers when several have required amputation after a machinery accident; in some cases of compound dislocation; in a few cases of disease—thus, in young subjects, in the case of the index finger, *e.g.*, where there is only one joint affected, and the mischief is limited to the articular surfaces and the bones themselves are sound. Excision of one of the above joints is best performed by an incision, 1½ inch long, to one side of the dorsum of the joint. A lateral incision is recommended by some (Maccormac). This interferes directly with the digital nerves and vessels. By a sufficiently free dorsal incision the extensor tendon can be readily separated from the bones beneath. The lateral ligaments being severed, the joint is dislocated, and the ends of the bones removed with a narrow, clean-cutting saw, the soft parts being as carefully protected from damage as possible.* Drainage being provided with a strand of aseptic horsehair, the wound is partly closed, and the finger put up somewhat flexed.† Careful passive movement should be commenced about the sixth day.

Conservative Surgery of the Hand.—While it is a cardinal principle to preserve every inch of the hand, a single finger or a thumb alone being far more useful than the most elaborate artificial limb that can be made, and that to gain this end it is frequently advisable to trim up an injured part and to remove dead bone in preference to doing any set amputation, it must always be remembered that a part may be capable of being saved, and yet ultimately be useless, unless it be at least partially movable. Where it is probable that both flexor tendons will die, amputation had best be performed in any finger except the index.

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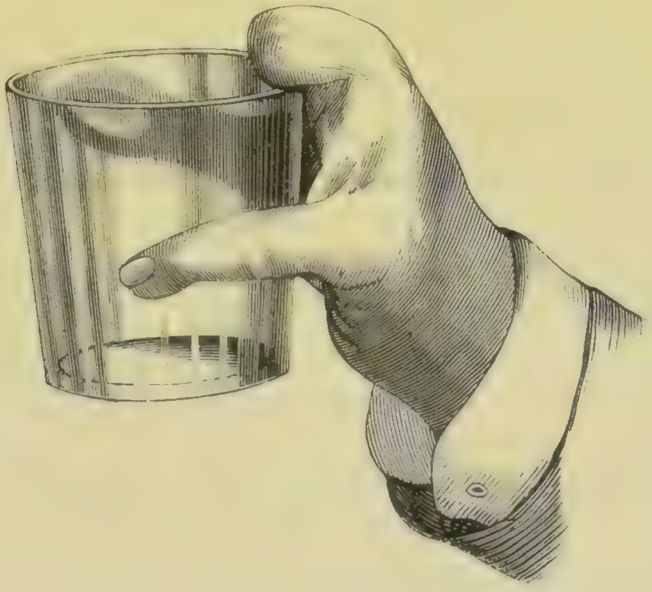
* If any tendons are cut, they should be united with sutures.

† On a carefully moulded felt splint, or one of perforated zinc.

One condition, which a surgeon in large manufacturing centres is certain to meet with, requires grave consideration, *i.e.*, where a hand is flayed, owing to its having been caught between rollers which hold, but do not crush; here, as the patient draws back, the skin is stripped off, like a glove, up to the wrist. If any bones are crushed, thecæ or the palmar fascia opened, amputation at the wrist should be performed at once; and Billroth (*Lect. on Surg., Pathology, and Therapeutics*, Syd. Soc. tr., vol. i. p. 207) advises this step where the skin is completely stripped off without other injury, fingers entirely deprived of their skin almost invariably becoming gangrenous, and the result being, "under the most favourable circumstances, nothing more than an unwieldy, cicatrized stump." Probably most surgeons would make an attempt in a young subject, and with the aid of antiseptics, irrigation, and skin-grafting as soon as possible, to save part at least of the hand. With this view secondary amputation is to be preferred.

The following (Fig. 8) is an excellent instance of what may be effected by conservative surgery here. It represents the relic of a hand, consisting of the thumb, stump of the index and of the little finger, and also shows how much flexion the shortened index is still capable of.*

FIG. 8.



RE-UNION OF SEVERED DIGITS.

The question will sometimes arise as to the advisability of attempting to re-unite portions of severed fingers and thumbs.

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* The figure is taken from a paper on Railway Injuries, by Dr. Thomson, of Kentucky—*Trans. Amer. Surg. Assoc.*, vol. ii. p. 190.

Many such successful cases have occurred, and the surgeon may well make the attempt, when the parts are cleanly severed, and when the patient is young and healthy, as is often the case in country practice.

The following are instances of the parts severed :—The first, second, and third fingers cut off above a diagonal line beginning in the middle phalanx of index finger and ending in last phalanx of third finger near the root of the nail. The parts had been lying in the snow for some time, and were kept for two or three hours before being applied. In other cases the part has been severed longitudinally, containing in it a portion of bone split off. The time between the injury and the treatment has varied from twenty minutes to three or four hours, and the severed part has been picked out of sawdust, brought up in dirty paper, whilst in a third the patient was sent back to find it in the field in which he had been reaping.

When there is the least shred of soft parts left holding on the severed bit, even a bad compound fracture of the finger with severe laceration of the soft parts may be saved.

The age and condition of the patient, the time which has elapsed since the injury, the part affected,—*i.e.*, whether index or thumb,—must all be considered. And in any case the patient should be warned that, though the attempt may succeed, the parts unite, and sensation be restored, the result may be a stiff and therefore comparatively useless member.

If it be decided to make the attempt, the part should be well cleansed with hot mercury perchloride solution (1 in 1000), united exactly with a few points of fine wire or carbolized silk, and horsehair sutures, enveloped in salicylic wool, and kept *in situ* with carefully adjusted splints of whalebone or perforated zinc. The dressings should not be disturbed for three days, if possible.*

WEBBED FINGERS (Figs. 9 and 10).

These should always be remedied as soon as possible in early childhood; if left untouched, the fingers may be useful, but the annoyance of the deformity will be serious.

1. The simpler methods—viz., wearing a large metal ring through a hole made where the cleft should begin, or passing large silver wire or fine drainage tubing through such a hole, the

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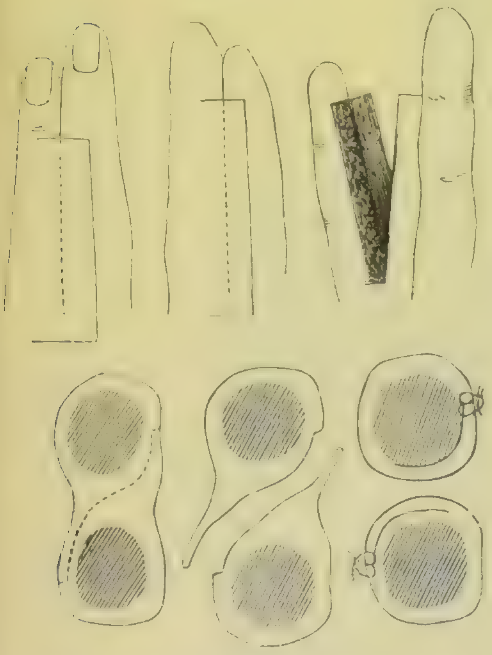
* Numerous cases of this kind will be found in the *Lancet* for 1861, vol. ii., and more recently (*Annals of Surgery*, March 1887, p. 263) fifteen such cases, with good results, have been tabulated by Dr. Pilcher.

ends of the tubing or wire being attached to a wristlet or bracelet,—may be tried first, and, when the perforation is soundly healed, the web should be slit up and the fingers kept apart.

2. If the above fail, one of the following plastic operations should be made use of:—

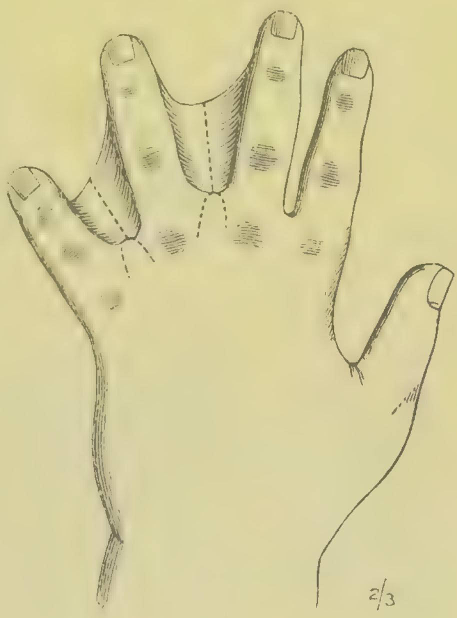
Didot's[*] (Fig. 9).—Two narrow longitudinal flaps are dissected up as thick as possible from the palmar and dorsal aspects of the affected fingers, and each flap is then folded round to cover in the raw surface of the finger to which it is attached, and secured with a few points of very fine interrupted sutures of carbolized silk and horsehair.

Fig. 9.



Didot's operation for webbed fingers. (Reeves.)

Fig. 10.



Norton's operation for webbed fingers.

Norton's[†] (Fig. 10).—Small triangular flaps are raised between the knuckles on the dorsal and palmar aspects; the webs are then cut through and the knife carried back so as to sever all the tissues up to the bases of the flaps, which are then very carefully stitched together without tension. The object is to ensure rapid union in the commencement of the cleft, and thus no re-development of the web. The flaps should be thick enough to avoid risk of sloughing, and somewhat narrow to prevent bulging. To prevent tension they should be sufficiently long, and any tissue between the knuckles that prevents their coming together should be cut away. The line of the natural web should be carefully observed.

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[*] A good account of these operations will be found in Mr. Reeves' *Orthopædic Surgery*.

[†] *British Medical Journal*, 1881, ii. 931.

CONTRACTED PALMAR FASCIA (Figs. 11 and 12).

It is well known that occasionally contraction of the palmar fascia takes place, especially that part of it going to the inner two fingers, being due partly to constitutional, partly to local, causes. Commencing about the transverse palmar creases, it steadily cripples the hand by drawing down the fingers, causing flexion at the metacarpo-phalangeal and inter-phalangeal joint (Fig. 11).

Operation.—This may be either open or subcutaneous; I much prefer the latter. The best is Mr. Adams' method,[*] by multiple punctures from above downwards. Either before the skin becomes adherent, or by finding some spot where adhesion of the skin to the fascia has not yet taken place, the surgeon, avoiding the site of the vessels, passes a delicate fascia knife, or a fine small tenotomy knife, between the skin and fascia, and divides the band from above downwards, taking care not to dip the point. In cases of contraction of two fingers, multiple punctures—*e.g.*, five to nine—may be required. It is very easy, by operating on the palmar cords, to rectify the contraction at the metacarpo-phalangeal joint. The straightening of the contraction often met with between the first and second phalanges is much more difficult. The digital prolongations of the fascia may be divided by punctures in the web between the fingers, extreme care being required to avoid the digital vessels and nerves by not dipping the point. But when the surgeon finds some difficulty in correcting this contraction thoroughly, I am of opinion that he will act most wisely by correcting the remaining contraction gradually by the use of a finger splint with rack and pinion movements opposite the metacarpo-phalangeal and inter-phalangeal joints.[†] When the punctures are made, they are dusted with iodoform, covered with sal-alembroth gauze, and the hand placed on the above splint, which is worn day and night at first, carefully padded at all pressure points. Some weeks will be required to correct the phalangeal contraction, and in advanced cases relapses can only be prevented by the persevering use of the splint. If the surgeon attempts to straighten completely in an advanced case of phalangeal as well as metacarpo-phalangeal contraction, he runs the risk (by dividing a digital nerve) of causing slight gangrene of the finger-tips or most intolerable pain.

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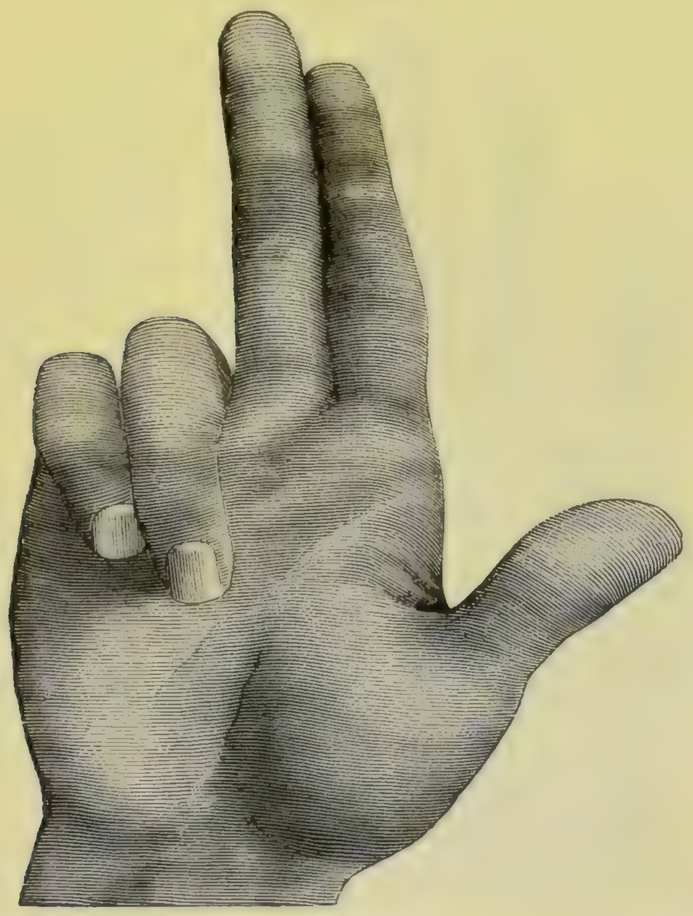
[*] *Finger Contraction and Depressed Cicatrices* (Churchill, 1879).

[†] *Loc supra cit.*, Fig. 10.

Figs. 11 and 12* represent the right hand crippled with contraction of the palmar fascia, before and five years after operation. The man was a patient of Dr. J. E. B. Burroughs, of Lee, and was operated on by me in 1883, the contraction of the metacarpo-phalangeal joints being straightened at once after numerous punctures made in the manner above given, while that at the inter-phalangeal joints was remedied chiefly by the persevering use of Mr. Adams' splint, already alluded to. The fingers are now, 1890, alsolutely straight, perfectly mobile, and free from the slightest tendency to contraction. It will be seen from Mr. Hogarth's drawing that some thickening, puckering, and corrugation of the palmar skin and fascia still persists, but this has now no power of producing contraction, the patient, one of the relieving officers to the Lewisham Union, being able to write, &c., without any hindrance whatever.

FIG. 11.



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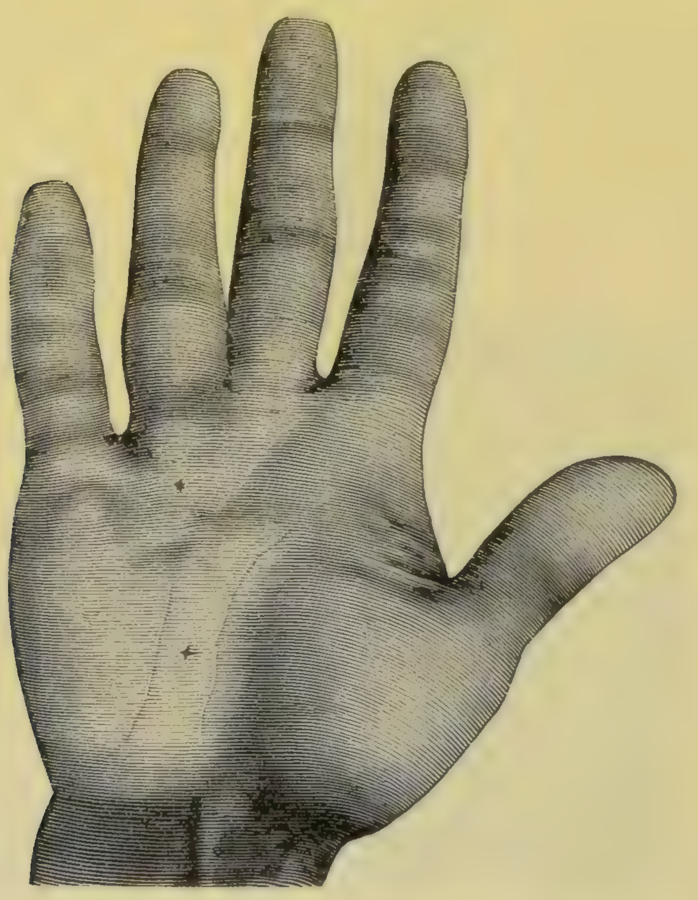
* The asterisks in Fig. 12 show spots where the fascia knife might be introduced in contraction of the palmar fascia slip going to the ring finger. The contracted band or bridle, thus isolated by the punctures, undergoes softening and atrophy.

If operation by open wound be preferred, the method of Goyraud may be made use of. It is recommended by Mr. Hardie,* of Manchester, who believes that mere subcutaneous division of the contracted palmar fascia cannot be sufficient if the thickened, puckered, hardened skin is left alone, and also that intimate adhesion of the altered skin to the fascia is so general that it is difficult, if not impossible, to get the knife between the two at a sufficient number of spots for adequate straightening by the subcutaneous method. While it may be readily admitted that Mr. Hardie's four cases gave good results up to the time reported, and that, if any open operation is really needed, this one is as good as any, the following objections to its general adoption in preference to that of Mr. Adams appear to me to be fair ones:—(1) The greater severity of an open operation in these patients, who are often not young, even when the wound is, by hands as careful as Mr. Hardie's, kept aseptic. (2) The more frequent dressings, the need of a drain, the fact that the wound does not heal for upwards of a week, and then, perhaps, not all by primary union; the presence of

FIG. 12.



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* *Medical Chronicle*, vol. i. No. 1, p. 9.

sutures which need removal, and the fact that, as in Case III., "general swelling of the hand" may take place and interfere with the use of splints. Finally, Mr. Hardie does not appear to me to attach sufficient importance to the value of Mr. Adams' splint, which, by gradual, quiet, persevering extension, causes atrophy of the now divided fascial cords, and thus renders, as a secondary result, the hardened skin over them more soft and supple, this taking place the more readily, the more extension by the splint, and passive movements, frictions, &c., are persevered with.

PALMAR HÆMORRHAGE.

There are three arterial arches especially concerned in keeping up the arterial supply here—viz., (α) superficial palmar; (β) deep palmar arch; (γ) the carpal arteries round the wrist. These are supplied with blood, not only from the radial and ulnar, but also from the interosseous arteries. Finally, if the comes nervi mediani is enlarged, it will join the superficial palmar arch, or one of the digital arteries.

Treatment.—This will vary accordingly as the case is seen early, or later.

A. EARLY CASES.—The surgeon arrests any bleeding* by pressure on the bleeding point while he has the limb raised, and arranges for compressing the brachial, or the radial and ulnar. This securely effected, he cleanses the wound, dries it carefully, and, if it gapes at all, endeavours to secure the cut vessel itself. If this fail, or if the wound be merely punctured, he at once carefully applies compression. And it may be said at once that, if this is wisely and efficiently done, no further hæmorrhage will take place; if incompletely or carelessly applied, the patient's limb and life may both be endangered.

The brachial being commanded and the wound dried, a compress—consisting of boracic lint, dusted with iodoform, pieces of sponges wrung out of carbolic acid, and dusted with iodoform and powdered steel sulphate, or lint soaked in carbolic oil or tr. benz. co., the pieces of lint or sponge increasing in size from a threepenny bit to half-a-crown—is got ready, together with strapping, bandages, lint, and two bits of pencil or bougie. The fingers are now carefully strapped and bandaged, and the compress is then secured in position by careful bandaging. If the above precaution is omitted, so much and so painful œdema of the fingers will take place, as to inevitably lead to early removal of the compress and recurrence of the hæmorrhage. The compress being in position, two bits of pencil wrapped up in lint are placed over the radial and ulnar, and the bandage carried up to mid-arm. The Esmarch being removed from the brachial, a splint is then applied, and the patient kept at first well under the influence of morphia. The compress should not be disturbed for three or four days at least.

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* The wound sometimes does not bleed when examined. If there is a history of much bleeding, bleeding *per saltum*, if the depth, &c., of the wound make it probable that an artery is wounded, pressure should be applied. A little later, and the hæmorrhage may break out on the least exertion; this is very likely to occur at night.

B. Later Cases.—If pressure has been tried, but inefficiently because inadequately at first, inflammation will probably have supervened, and the hand will very likely be red, brawny, painful, suppurating. If hæmorrhage still continue after the parts are relieved by carefully made incisions* it will be wiser to tie the brachial artery at once in the middle of the arm (p. 83) than to tie the radial and ulnar in the lower third of the forearm (pp. 40, 42), and for these reasons:—

i. While the anastomoses round the elbow are so free and so reliable as to prevent any risk of gangrene after a ligature of the main vessel, ligature of the radial and ulnar is rendered uncertain owing to—

(*α*) The anastomoses between the two palmar arches;
(*β*) The anastomoses between these and the carpal arteries;
(*γ*) The blood brought down by the interosseous arteries and the comes nervi mediani, which will not be stopped by ligature of the radial and ulnar;
(*δ*) The fact that, if inflammation has set in, enlargement of the arteries will have taken place.

ii. Ligature of the brachial, by cutting off so much blood, will also cut short the inflammation.

iii. Ligature of the brachial will be performed through healthy and uninflamed parts.

An interesting instance of what pressure will effect even if deferred till the eleventh hour is seen in the following case, published by Mr. Skey, *Lancet*, 1855. A patient nearly three weeks after the wound, having had attacks of recurrent hæmorrhage, entered St. Bartholomew's Hospital, and Mr. Skey tied the radial and ulnar. When the ligature separated from the ulnar, hæmorrhage took place, and the artery was again tied in the middle third. Hæmorrhage recurring, the brachial was tied in the lower third. This last operation failed to arrest the hæmorrhage, and the third part of the axillary was tied. About ten days later profuse hæmorrhage from the axillary wound left the patient almost pulseless. The patient's condition not admitting of amputation at the shoulder, the limb was firmly bandaged from the hand to the shoulder. No further bleeding took place, and the man made a good recovery, with a useful arm.

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* Incisions for suppuration in the hand should be made opposite to the centres of the phalanges, opposite to the heads of the metacarpal bones, above the superficial palmar arch by Mr. Hilton's method, and, if above the wrist, the position of the arteries, which may, perhaps, be superficial, and of the median nerve, lying close to the inner side of the palmaris longus, must be remembered.

In the *Lancet*, 1859, vol. i. p. 506, is a good instance of the results of pressure inefficiently applied. The compress, which had been applied to the palmar wound (the man having been made an out-patient), was removed every day, and followed by hæmorrhage. Severe bleeding occurred on the fifth day, ligature of the radial was performed on the seventh, and on the ninth ligature of the brachial low down. On the eleventh, owing to recurrence of hæmorrhage, the arm was amputated just above the ligature. Chronic pyæmia followed, from which the patient was slowly recovering at the close of the report. No abnormal distribution of vessels was found in the arm.

OPERATIONS FOR UNION OF DIVIDED TENDONS.

These may be referred to here from the frequency with which the flexor and extensor tendons of the fingers and wrist are liable to be severed.

As in the case of divided nerves, the union of tendons may be primary or secondary, according as the surgeon is called to the case at once or later. For general details the reader is referred to the chapter on Nerve-suture.

The upper end will probably give more trouble than in the case of a nerve, owing to its greater retraction. In laying open the sheath to follow up the tendon, most scrupulous care must be taken to use every aseptic precaution. Sutures of fine silk are preferable to those of chromic gut.* In the case of secondary suture, the tendon ends must be refreshed.

When several tendons have been divided, uniting each end accurately to its fellow is often troublesome.

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* There is always a risk that gut sutures, however prepared, will give way too soon, especially if suppuration occur.

If the upper end cannot be found after careful search and sufficient slitting up of the sheath, the lower end may be successfully attached to a neighbouring tendon.

When the ends are widely apart, and apposition is unobtainable, long threads—"distance-sutures"—have of late years been used, with some success, to connect the ends. B. Anger first made use of sutures of this kind for the tendon of the extensor minimi digiti; the two ends were 9 cm. apart, but traction reduced the distance to 2 cm., and they were connected by a silver suture, with a satisfactory result.* New tendon appears to be regenerated along the threads. The operation is clearly indicated whenever apposition is impossible, as after removal of a neuroma; it is more particularly applicable to tendons without a sheath.

M. Peyrot (*Bull. de la Soc. de Chir.*, 1886, p. 357) has succeeded in transplanting the tendon of a dog, and, in another case, that of a cat, into the gaps of divided tendons in man. The transplanted piece is said to have lived, and a fair amount of flexion of the finger to have been obtained. Whether this will be found preferable in its results to distance-sutures remains to be seen.

Mr. Robson (*Clin. Soc. Trans.*, vol. xxii. p. 291) successfully grafted 4½ inches of flexor tendon from a finger too much smashed to save, on to the dorsum of the hand, so as to form a new extensor for the index finger, the tendon of which had been completely torn away. The proximal end of the tendon was stitched to the fleshy belly of the extensor communis where the tendon had been previously attached, the distal end being fixed to the small portion of tendon left near its insertion into the phalanx. The case, which is an excellent instance of conservative surgery, ended in recovery with a most useful limb. During extension of the index the new tendon could be felt to move under the skin.

The following cases are good instances of tendon-suture; they are reported by Dr. v. Fillenbaum, of Vienna:†—

CASE I.—Oblique cut with a bread-knife, involving the common extensor of the index and middle finger, and the extensor indicis, the central end of the latter retracted so far that it could not be reached, unless by slitting up its sheath. The tendons of the common extensor were each united by two fine silk sutures.

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* The above remarks on distance-sutures are taken from an abstract of a paper by M. Assaky, *Revue de Chirurgie*, November 1886, in the *Annals of Surgery*, April 1887, p. 348. The same surgeon (French Congress of Surgery, *Brit. Med. Journ.*, 1886, vol. ii. p. 1194) thought that the *suture à distance* should be employed to promote continuity in cases where separated portions of muscle and bone, as well as tendon and nerve, cannot be brought together. If employed after resection of joints, the catgut would form artificial ligaments, which would be rapidly converted into fibrous bundles.

† *Wien. Med. Woch.*, Nos. 29 and 30, 1885; *Annals of Surgery*, November 1885, p. 427.

The accessible peripheral end of the extensor indicis was attached to both ends of the sutured tendon from the extensor communis to the index finger. The strongly stretched extensor tendons of the second and third fingers were now fixed (to prevent retraction by muscular action) by silk sutures passed, 2 cm. higher up, through skin and tendon sheath, and tied over a roll of iodoform gauze. These were removed on the fifth day. Passive movement was begun on the sixteenth day. Six months later the man had perfect use of his fingers.

CASE II.—Razor cut on back of left thumb; operation six weeks later. The thumb was found strongly adducted, and bent into the palm. Active extension impossible. A serous fistula was left. The parts being made evascular, the tendon ends, found but a few mm. apart and closely adherent to the sheath, were trimmed with scissors and united with silk sutures. Two mm. above the central end on the radial side a fine silk suture was passed outwards, and again in towards the palm, through the whole thickness of the tendon, then back again towards the palm, and out at the ulnar side. After closely adapting the two tendon ends, the silk was passed through the peripheral end in a reverse order, and finally the two suture ends were tied on the radial side of the tendon. A fixation-suture was used as in the previous case. Four months later the movements of the thumb were normal; only at the place of the fixation-suture the skin and tendon sheath were adherent, as shown by the folding in of the skin on extension.

I may take this opportunity of saying that in the treatment of an incised wound of the hand or foot the condition of the tendons should be cleared up as well as that of the vessels. The practitioner too often rests satisfied with arresting the urgent hæmorrhage. The wound heals quickly, but loss of power remains. The following is a good instance:—In August 1888, H. P., aged thirty-one, was sent to me with a constant flexion of, and inability to extend, the last two phalanges of the thumb. A few months before he had been treated for severe hæmorrhage from an incised wound of the dorsum over the first phalanx and metacarpal bone of the right thumb. By dissection the extensor secundi internodii was found to be divided, the upper end being found by following up the sheath. The extensor primi had been only partially divided, for three-quarters of its width. After trimming, the two ends of the extensor secundi were separated by an interval of an inch on complete extension of the thumb. Use of a stout silk suture and pushing down the upper end of the tendon left the ends still separated by $\frac{1}{4}$ inch ; two very fine silk sutures brought the ends into good but not exact apposition. On hyper-extending the thumb the V-shaped notch in the partially divided extensor primi was obliterated, so no sutures were used here. The notch was merely refreshed. A horse-hair drain was inserted, the superficial wound closed with fishing-gut. Irrigation with hyd. perch. 1 in 2000 was made use of, and a splint applied on the palmar aspect so as to keep the thumb hyper-extended. Morphia was given freely. When seen two months later, the patient had recovered complete extension.

The above remarks apply chiefly to tendons of the upper extremity. The tendo Achillis is another which the surgeon may be called upon to suture. An admirable instance of this, in a carpenter whose adze slipped, severing the tendon and opening the ankle-joint, will be found recorded by Dr. Gipps (*Lancet*, 1887, vol. i. p. 16). The ends of the tendon (the upper one having retracted much) were here united with three silver sutures twisted. A fortnight later, an attempt made to remove these was abandoned owing to the free oozing of blood, the ends being cut off short. The patient recovered with perfect use of the joint, the sutures being completely buried.

CHAPTER II.

OPERATIONS ON THE WRIST.

EXCISION OF THE WRIST JOINT (Figs. 13 and 14).

THE reasons for this operation often failing, and the conditions needful for success, may be first considered.

1. Whether the disease begins in the synovial membrane as a synovitis, pulpy, gonorrhœal, rheumatic, &c., or whether, as more rarely, it begins primarily in the bones, it extends rapidly, not only to the wrist-joint, but to the two rows of carpal bones and the bases of the metacarpals, along the complicated synovial membranes,* which bring all these bones into contiguity with each other. The disease, thus extensive, is also most obstinate, and is, in adults, often further complicated by a tendency to phthisis. Thus partial operations are useless, and often worse than useless. Sir J. Lister† was the first to insist on the importance, and to show the possibility, of removing every atom of the disease, including the ends of the radius and ulna, the two rows of carpal bones, and the bases of the metacarpus (Fig. 13).

2. From the close relation of the flexor and extensor tendons in front and behind these complicated joints, and from the numerous grooves on the bones, it is most difficult to extirpate the

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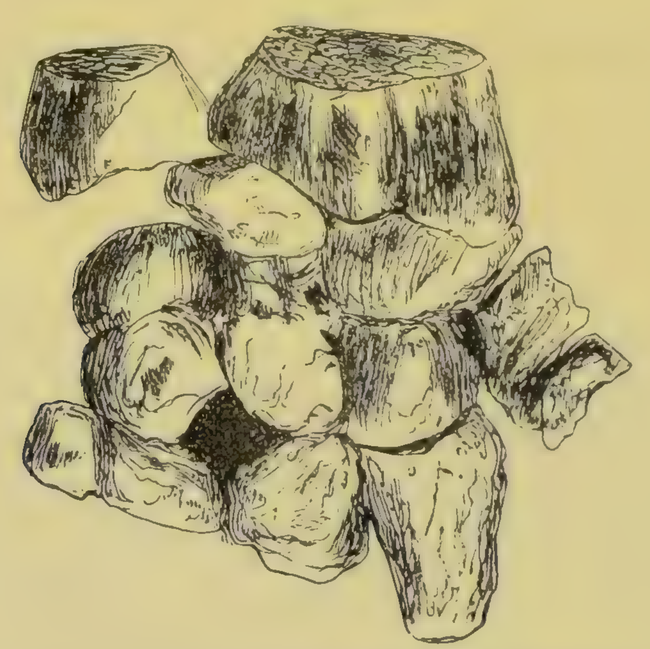
* The arrangement of these, five in number, must be remembered, and their close vicinity to each other. (1) The membrana sacciformis of the inferior radio-ulnar articulation, passing from the lower end of the ulna to the sigmoid cavity of the radius, and lining the upper surface of the triangular fibro-cartilage. (2) That of the wrist-joint proper, passing from the lower end of the radius and the inter-articular fibro-cartilage above to the bones of the first row below. (3) The common synovial membrane of the carpus, the most extensive of all, passing from the lower surface of the scaphoid, semilunar, and cuneiform above to the upper surface of the bones of the second row, sending up two prolongations between the scaphoid and semilunar and the semilunar and cuneiform, and also sending downwards three processes between the four bones of the second row, prolonged down into the carpo-metacarpal joints of the four inner metacarpal bones. (4) A separate one between the cuneiform and pisiform. (5) Another separate one between the trapezium and metacarpal bone of the thumb.

† *Lancet*, 1865, vol. i. p. 308. From this paper Fig. 13 and the steps of the operation are taken.

disease without disturbing the tendons. On the other hand, however stiff the wrist may be left, flexion and extension of the fingers is absolutely needful for the operation to be a success; hence it is imperative that, throughout the prolonged operation, the tendons should be disturbed as little as possible, a direction very difficult to follow, as their cellular sheaths are often "pulpy," and the necessary manipulations of the tendons* during the operation may easily lead to their sloughing, and thus to a useless "fin-like" hand.

FIG. 13.



Parts removed in excision of the wrist. (Lister.)

3. Passive movement of the fingers should be begun as early as possible, and most perseveringly maintained.

Sir J. Lister's Operation.—An anæsthetic being given, and the parts rendered bloodless by Esmarch's bandages, any adhesions of the tendons are thoroughly broken down. The radial incision is then made, as in Fig. 14. This incision is planned so as to avoid the radial artery and also the tendons of the extensor secundi internodii and indicis. It commences above at the middle of the dorsal aspect of the radius on a level with the styloid process. Thence it is at first directed towards the inner side of the metacarpo-phalangeal joint of the thumb, running parallel in this course to the extensor secundi internodii; but, on reaching the line of the radial border of the second metacarpal bone, it is carried downwards longitudinally for half its length, the radial artery being thus avoided, as it lies a little farther out. These directions will be found to serve, however much the parts may be obscured by inflammatory thickening. The tendon of the extensor carpi radialis longior is next detached with the knife, guided by the thumb-nail, and raised, together with that of the extensor brevior, also cut, while the extensor secundi internodii, with the radial artery, is thrust somewhat outwards. The next step is the separation of the trapezium from the rest of the carpus by cutting forceps applied in a line with the longitudinal part of the incision, great care being taken of the radial artery. The removal of the trapezium is left till the rest of the carpus has been taken away, when it can be dissected out without much difficulty, whereas its intimate relations with the artery and neighbouring parts would cause much trouble at an earlier stage. The hand being bent back to relax the extensors, the ulnar incision should next be made very free by entering the knife at least 2 inches above the end of the ulna immediately anterior to the bone, and carrying it down between the bone and flexor carpi ulnaris, and on in a straight line as far as the middle of the fifth metacarpal bone at its palmar aspect. The dorsal lip of the incision is then raised, and the tendon of the extensor carpi ulnaris cut at its insertion, and its tendon dissected up from its groove in the ulna, care being taken not to isolate it from the integuments, which would endanger its vitality. The finger extensors are then separated from the carpus, and the dorsal and internal lateral ligaments of the wrist-joint divided, but the con-

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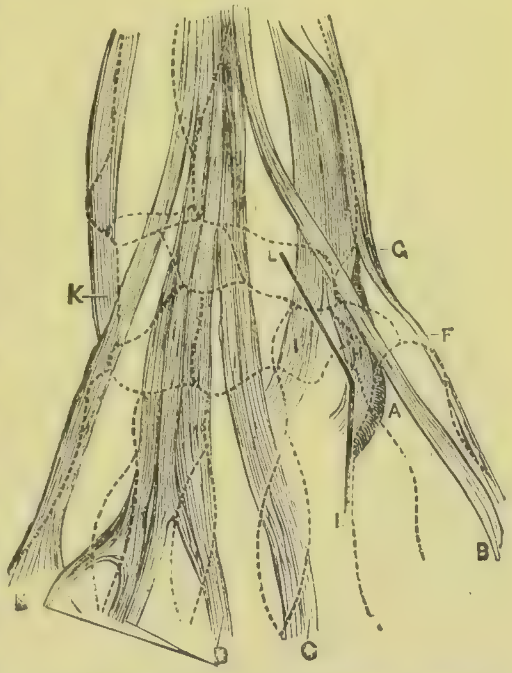
* Mr. Erichsen (*Surg.*, vol. ii. p. 383) writes thus of this point: "If we look at the tendons which surround the wrist, we shall find them divisible into five groups —(1) Those special to the thumb; (2) The extensors of the fingers; (3) The flexors of the fingers; (4 and 5) The flexors and extensors of the wrist. Now, the incisions should be so planned as to save absolutely the whole of the first three groups and to divide only the tendons of the wrist proper, and these are cut so close to their insertions that, as a rule, they form new attachments, and resume their functions as recovery takes place."

FIG. 14.



A, Radial artery. B, Extensor secund internodii pollicis. C, Extensor indicis. D, Extensor communis. E, Extensor minimi digiti. F, Extensor primi internodii. G, Extensor ossis metacarpi. H, Extensor carpi radialis longior. I, Extensor carpi radialis brevior. K, Extensor carpi ulnaris. L L, Line of radial incision. (Lister.)

nections of the tendons with the radius are purposely left undisturbed. Attention is now directed to the palmar side of the incision. The anterior surface of the ulna is cleared by cutting towards the bone so as to avoid the artery and nerve, the articulation of the pisiform bone opened, if that has not been already done in making the incision, and the flexor tendons separated from the carpus, the hand being depressed to relax them. While this is being done, the knife is arrested by the unciform process, which is clipped through at its base with pliers. Care is taken to avoid carrying the knife farther down the hand than the bases of the metacarpal bones, for this, besides inflicting unnecessary injury, would involve risk of cutting the deep palmar arch. The anterior ligament of the wrist-joint is also divided, after which the junction between carpus and metacarpus is severed with cutting pliers, and the carpus is extracted from the ulnar incision with sequestrum forceps, and touching with the knife any ligamentous connections. The hand being now forcibly everted, the articular ends of the radius and ulna will protrude at the ulnar incision. If they appear sound, or very superficially affected, the articular surfaces only are removed. The ulna is divided obliquely with a small saw, so as to take away the cartilage-covered rounded part over which the radius sweeps, while the base of the styloid process is retained. The ulna and radius are thus left of the same length, which greatly promotes the symmetry and steadiness of the hand, the angular interval between the bones being soon filled up with fresh ossific deposit. A thin slice is then sawn off the radius parallel with the articular surface. For this it is scarcely necessary to disturb the tendons in their grooves on the back, and thus the extensor secundi internodii may never appear at all. This may seem a refinement, but the freedom with which the thumb and fingers can be extended, even within a day or two of the operation, when this point is attended to, shows that it is important. The articular facet on the ulnar side of the bone is then clipped away with forceps applied longitudinally.

If the bones prove to be deeply carious, the pliers or gouge must be used with the greatest freedom. The metacarpal bones are next dealt with on the same principle, each being closely investigated, the second and third being most readily reached from the radial, the fourth and fifth from the ulnar, side. If they seem sound, the articular surfaces only are clipped off, the lateral facets being removed by longitudinal application of the pliers.*

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* As an instance of what may be taken away, in one case Sir J. Lister not only

The trapezium is next seized with forceps and dissected out without cutting the tendon of the flexor carpi radialis, which is firmly bound down in the groove on the palmar aspect, the knife being also kept close to the bone so as to avoid the radial. The thumb being then pushed up by an assistant, the articular end of its metacarpal bone is removed. Though this articulates by a separate joint, it may be affected, and the symmetry of the hand is promoted by reducing it to the same level as the other metacarpals.

Lastly, the articular surface of the pisiform is clipped off, the rest being left if sound, as it gives insertion to the flexor carpi ulnaris and attachment to the anterior annular ligament. But if there is any suspicion as to its unsoundness, it should be dissected out altogether, and the same applies to the process of the unciform.

The only tendons divided are the extensors of the carpus, for the flexor carpi radialis is inserted into the second metacarpal below its base, and so escapes. Merely one or two small vessels require ligature. Free drainage must be given. The hand and forearm are put up on the well-known splint of Sir J. Lister, with the cork support for the hand, which helps to secure the principal objects in the after-treatment—viz., frequent movements of the fingers—while the wrist is kept fixed during consolidation.

Passive movement of the fingers is begun on the second day, whether the inflammation has subsided or not, and continued daily. Each joint should be flexed and extended to the full extent possible in health, the metacarpal bone being held quite steady to avoid disturbing the wrist. By this means the suppleness gained by breaking down adhesions under chloroform is maintained.

Pronation and supination, flexion and extension, abduction and adduction, must be gradually encouraged as the new wrist acquires firmness. When the hand has acquired sufficient strength, freer play for the fingers should be allowed by cutting off all the splint beyond the knuckles. Even after the hand is healed, a leather support should be worn for some time, accurately moulded to the front of the limb, reaching from the middle of the forearm to the knuckles, and sufficiently turned up at the ulnar side. This is retained *in situ* by lacing over the back of the forearm.

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removed the base of the third metacarpal bone, but drilled its shaft into a hollow tube, a sound and most useful hand being retained.

Other Methods of Wrist Excision :—

BY SINGLE DORSAL INCISION.—The following account of von Langenbeck's operation is taken from Sir W. Maccormac (*Surg. Oper.*, pt. ii. p. 374),* who considers this method very superior to Sir J. Lister's, which "is at once complicated and difficult." The parts having been rendered bloodless and any adhesions broken down, a straight incision is made near the middle of the back of the wrist, the guide being the radial border of the extensor indicis tendon. The hand being slightly abducted, the incision begins close to the ulnar margin of the index metacarpal at the middle of the bone. The extensor indicis tendon should be first pushed to the ulnar side, and the soft parts incised down to the bone, which is here subcutaneous. The incision is prolonged upwards for 4½ inches to terminate over the radius at the angle of junction of the extensor indicis and extensor secundi internodii. Over the metacarpal bone it lies along the radial side of the extensor indicis and a little higher up on the ulnar border of the extensor carpi radialis brevior, close to its insertion. The dorsal ligaments of the wrist are divided in the deeper portion of the wound, but the radio-ulnar joint should not be opened, as this makes it afterwards difficult to expose the end of the ulna. It is a matter of much importance to avoid opening the tendon sheaths. The extensor indicis is exposed in the lower part of the wound. Near the centre the extensor carpi radialis brevior is seen, and may be divided close to its insertion. The extensor carpi radialis longior is treated similarly. A little patience is now required to detach the extensor tendons from the back of the radius, especially those of the thumb. The soft parts are first drawn by a retractor towards the radial side, and, the capsule being split, they are raised by the elevator, the tendons in their sheaths being carefully detached from their grooves—viz., extensor secundi, extensor longior and brevior, extensor primi, and extensor ossis metacarpi. Then, by introducing the elevator on the ulnar border of the wound, the extensor indicis, communis digitorum, minimi digiti, and carpi ulnaris are also raised, their connection with the dorsal ligament on one side and the periosteum and capsule of the joint on the other being preserved; in this way all chance of injury to their sheath is avoided. The soft parts being now thoroughly elevated on both sides of the wound, we obtain, on retracting them and slightly flexing the wrist, a complete view of the articulation. The radio-carpal joint lies open, and, on the hand being further flexed, the surface of the first row of the carpus will project in the wound. The bones may be readily removed in succession with the elevator, at the same time any ligaments which impede extraction being divided with the knife. First, separate the scaphoid from its connection with the trapezium; secondly, detach the semilunar and cuneiform. Now the second row of the carpus can be removed. The round head of the os magnum is steadied with the fingers of the left hand, an assistant abducts the thumb, and the knife divides the articulation between the trapezoid and trapezium. The carpo-metacarpal joints are entered in a direction towards the ulna, whilst the dorsal ligaments at the proximal ends of the metacarpal bones are divided as the assistant flexes the hand. The trapezoid, os magnum and unciform can now be removed *en bloc.* The hook-like process of the unciform requires care during its enucleation. It may be snipped off to facilitate removal of the bone, but with a little care it can be cut out. As a rule, the pisiform bone need not be interfered with; it is generally healthy. Through it the flexor carpi ulnaris finds an insertion into the base of the fifth metacarpal, and thus forms an important connection with the abductor minimi digiti. It is better not to remove the trapezium, as it forms a separate joint with the thumb, and is usually exempt from disease. The abductor, opponens, and flexor brevis pollicis arise from it. Its extraction, besides, is not easy, as the tendon of the flexor carpi radialis runs in a groove on its anterior surface, while the radial is in dangerous proximity on its outer side. It now remains to cut off the articular surfaces of the radius and ulna. The hand being still flexed, these bones project from the wound, and with a narrow saw the ends can be quite easily removed. The external lateral ligament, with the periosteum, must be carefully detached with the elevator, otherwise the radial may be cut as it runs over the trapezium to penetrate the first interosseous space. It facilitates this step not to have previously opened the radio-ulnar joint. The resection of the radius should be as limited as possible. Finally, the cartilages of the metacarpal bones are cut off. All gelatinous granulations should be scrupulously removed, and the wound disinfected.

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* My old friend G. A. Wright, of Manchester, has made use of a similar incision (*Abstr. of Med. and Surg. Cases treated at the Pendlebury Hospital*, 1884, p. 133). In a child of nine, with phlyctenular ophthalmia, enlarged glands, and many marks of strumous disease, the right wrist was disorganized. "A single longitudinal incision for 3 or 4 inches was made between extensor communis and extensor secundi, the carpal joints opened, and the bones easily shelled out; the ends of the metacarpal bones and of the radius and ulna were removed with a gouge; one vessel was twisted; no tendon was divided, except in the sense of turning back the extensors of the carpus from their attachments. Six months later, the hand, which before the operation was bulbous, flabby, and useless, was all but healed, and had well shrunken; there was excellent power and mobility." In the very young, when disease occurs in this joint, which is most rare, extensive scooping out of carious bones and scraping out of sinuses may be undertaken, although no set operation can be done, owing to the tiny size of the parts. In 1877 I removed five of the carpal bones by a single dorsal incision in an infant aged two years and a half, a patient of Dr. T. Eastes, of Folkestone, the sinuses present being thoroughly scraped out with a sharp spoon. The result was most satisfactory, both as to the permanency of the cure and the usefulness of the fingers.

In this, as in Sir J. Lister's, or any excision of the wrist, great care must be taken not to open the radial artery, not to interfere with the palmar surface more than can be helped, to preserve any sound though inflamed periosteum, not to damage the tendons * with retractors, &c., and finally to adopt early, and to persevere with, movements of the fingers.

EXCISION OF THE WRIST FOR INJURY.—This will be still more rarely required. Mr. Pye (*Med. Times and Gaz.*, 1879, vol. ii. p. 582) has published a case of compound dislocation in an adult. Some bones were protruding through a transverse rent on the front of the wrist, the radial artery was uninjured, the ulnar could not be felt. The flexor carpi radialis and flexor longus pollicis were torn across. The ends of the radius and ulna were sawn off and the carpal bones removed, piecemeal, until only the trapezium and the distal part of the os magnum, which were apparently uninjured, were left. Strict antiseptic precautions were taken, and the wound healed rapidly. There was a steady regain of power in the wrist and hand, the patient being again able to carry his milk-pails.†

Excision of Wrist for Gunshot Injury.—Dr. Otis‡ states that ninety-six cases of excision of the wrist, varying much in extent, were returned. Six of these were complete, and five recovered with the functions of the hand much impaired, but, all things taken into consideration, in a better condition than if they had been submitted to amputation. In the ninety partial excisions, ankylosis and extreme deformity appear to have been common.

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* If any of the tendons are unavoidably so interfered with that a portion is likely to slough, it would be well to cut out this part, and unite the ends with a carbolized silk suture. And where much manipulation of a tendon is unavoidable, it would be better to divide it, and unite it subsequently.

† Sir W. Maccormac (*Dub. Quart. Journ. Med. Sci.*, 1867, p. 281) publishes the case of a girl, aged ten, in whom he removed the whole of the left carpus and most of the metacarpus, for a machinery accident, the patient recovering with a useful limb.

‡ *Med. and Surg. Hist. of the War of the Rebellion*, part ii. p. 999 *et seq.*

Generally the hand was strongly deflected to the radial side,* the fingers rigidly fixed, the skin over the projecting end of the ulna irritable and exposed to injury. "With our present experience of excisions of the wrist for injury, it seems probable that recovery unattended by ankylosis is seldom to be anticipated, yet that this result is not disastrous, provided the hand is in good position and the functions of the fingers are in some degree preserved." In a very few, loose, flail-like joints were observed, remediable by apparatus.

The chief English authority, Sir T. Longmore, writes thus on this operation:†—"Gunshot wounds of the wrist are usually attended with so much injury to the tendons and other structures surrounding the joint that it is scarcely possible in such cases for the operation of resection to produce satisfactory results."

Causes of Failure after Excision of the Wrist.—These are, mainly:

1. Persistent sinuses and discharge set up by remaining caries or necrosis. Sir W. Fergusson (*Path. Soc. Trans.*, vol. viii. p. 391) showed a specimen in which all the bones had been supposed to have been removed by a single incision on the ulnar side. The pisiform, trapezium, and part of the unciform had been left. The movement of the fingers was good, but sinuses remained on both sides communicating with a bare piece of radius. Death took place from phthisis. Mr. J. Hutchinson (*ibid.*, vol. xvii. p. 239) showed a specimen of wrist-joint after partial resection by Mr. Stanley. Though no active caries was present, discharge was kept up by a necrosed bit of bone in a cavity at the back of the carpus. Death here also took place from chronic phthisis.
2. Matting and sloughing of tendons, and consequent stiffness of fingers.
3. Phthisis.

AMPUTATION THROUGH THE WRIST-JOINT

(Figs. 15 and 16).

The value of this operation has been a good deal disputed. It has been thought by some‡ "that it possesses no particular advantage; the length of the stump is of no great consequence; the flaps, with the numerous tendons in them, may not heal readily."

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* As this appears to be irremediable by any apparatus, Dr. Otis suggests that it should be met by always removing the carpal end of the ulna at the same level with the section of the radius, whenever it is necessary to remove the lower end of the latter.

† *Syst. of Surg.*, vol. i. p. 552.

‡ Sir W. Fergusson, *Pract. Surgery*, p. 325.

Others* have gone farther, and said that the long stump is found by instrument makers difficult to fit with an artificial hand. That this is certainly not always the case is shown by Mr. H. Bigg† from two cases, one a Commander R.N., the other an artisan in the Woolwich Arsenal, both of whom, after being fitted with artificial hands, were able to engage actively in their respective employments.

As the above objections are scarcely sufficient, and as this amputation preserves, if the parts heal quickly, good pronation and supination, it should be practised whenever opportunities arise. These, however, as is shown below, will not be numerous.

Indications.

1. Extensive injuries (gunshot and otherwise) of a hand not admitting of the preservation of any fingers, and in which the damage of soft parts does not necessitate amputating through the forearm.

2. Disease of carpus locally too far advanced for excision, or rendered by age, condition of health, &c., inappropriate for excision.

3. Cases of failed excision.

But in carpus disease the soft parts are often so much damaged by sinus formation and other results of the disease that the surgeon is driven to amputate higher up; and where this may not be the case, the articular surfaces of the radius and ulna, owing to disease, have to be removed, the operation thus ceasing to be correctly amputation through the wrist-joint.‡

4, 5, and 6. More rarely still, for the results of palmar suppuration, gangrene, or burns.

Operations.—As in other amputations where the amount of skin available varies considerably, several methods will be given. The first of these is the best.

Different Methods.

1. Long palmar flap (Figs. 15, 16).
2. Equal antero-posterior flaps.
3. Method of Dubreuil (Fig. 16).
4. Circular amputation.
5. Long dorsal flap, by Teale's method.

1. **Amputation by a Long Palmar Flap** (Figs. 15 and 16).—This has the advantage of preserving skin thick, well used to

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* John Bell, *Manual of Surgical Operations*, p. 53.

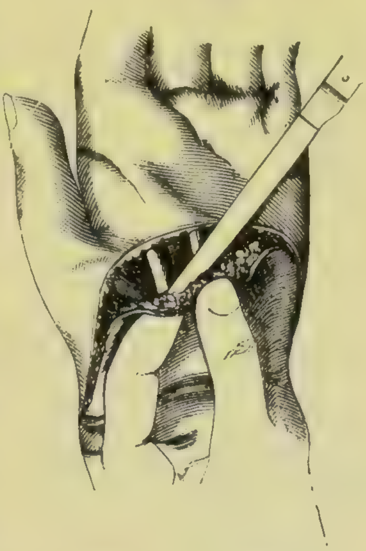
† *Artificial Limbs and Amputations*, p. 83.

‡ Disarticulation has these advantages over removal of the styloid processes:—(1) There is no risk of necrosis. (2) Rotation of the forearm is not interfered with. (3) The supinator longus is left to powerfully flex the forearm. (4) The stump is longer and more useful.

pressure, and abundantly supplied with blood; the nerves are also cut square, and disarticulation is easy.

The brachial artery being secured, the hand supinated,[*] and the wrist extended, an incision is made (on the left side) from the tip of the styloid process of the radius[†] straight down well on to the thenar eminence, and then, curving across (about on a line with the superficial palmar arch[‡]), and marking out a well-rounded flap by passing upwards over the hypothenar eminence to the tip of the styloid process of the ulna. This flap is next dissected up, without scoring, as far as the level of the wrist-joint; it should contain on its under surface some of the fibres of the thenar and hypothenar muscles. If this precaution is taken, the flap will contain the superficialis volæ and ulnar arteries, and thus run no risk of sloughing.

FIG. 15.



The hand being now pronated and flexed at the wrist-joint, an incision is made slightly convex across the wrist from one styloid process to the other. The palmar flap being now retracted, the hand is strongly flexed and the joint opened, on the outer side first; the soft parts in front and behind are now severed with a circular sweep (the assistant pulling slightly on the hand), the remaining ligaments divided, and the hand removed. If the articular cartilages of the radius are diseased, they must be dealt with either by gouging or, if necessary, by a clean section above the articular cartilage, a step which will interfere with free pronation and supination later on. The apices of the styloid processes should in any case be removed, but the base of that of the radius should always be left, if possible, to secure the action of the supinator longus.

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[*] If the operation is, thus, commenced from the front, the hand need only be turned over once. If the dorsum is attacked first, the hand must be turned twice, first, to make the palmar flap, and secondly, to disarticulate (Farabeuf).

[†] The tip of this is nearly on a level with the intercarpal joint, being ½ inch below and somewhat in front of the styloid process of the ulna. On a level with the latter will be found the line of the wrist-joint. The two furrows in front of the wrist are both below the level of this joint. The lower one corresponds to the upper edge of the anterior annular ligament and the intercarpal joint. If the soft parts are much swollen, comparison with, and measurements taken from, the opposite wrist will be helpful.

[‡] This level is usually low enough. If the parts on the dorsum are damaged, the palmar incision may be made longer. Mr. Barwell (*British Medical Journal*, August 30, 1873) advises bringing the incision as low as the crease in the palm, which is due to flexion of the fingers. It will be remembered that while the integuments on the dorsum retract freely, those on the front do so scarcely at all.

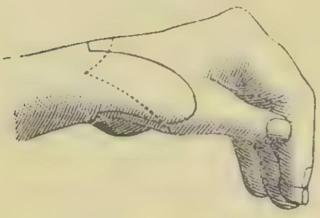
The radial, ulnar, the two interosseous, and the superficialis volæ arteries will probably need securing. Any sinuses are now scraped out with sharp spoons, and the tendons trimmed. From the facility with which these last slip up into their sheaths, antiseptic precautions should be carefully taken.

Another Method.—This consists of marking out the palmar flap (but not dissecting it up), opening the joint by a dorsal incision as above given, and then cutting the palmar flap by transfixion, the knife being passed behind the bones. As in this method it is difficult not to hitch the knife on the pisiform and unciform bones, and to avoid a jagged edge to the palmar flap, and as the flexor tendons, being relaxed, are pulled out by the knife instead of being cut cleanly, I do not recommend it.

2. **Amputation by Equal Antero-posterior Flaps.**—The surgeon may be obliged, where the soft parts are scanty, to make use of this method. The objections to it are that if the tissues are thin there is some risk that the cicatrix may be adherent to the bones, and that these will be but poorly covered. During healing the drainage is less satisfactory.

3. **Amputation at the Wrist by the Method of Dubreuil*** (Fig. 16).—In a few rare cases, *e.g.*, where the soft parts on the back and front of the wrist are much damaged, perforated by sinuses, &c., this ingenious method may be made use of.

FIG. 16.



The hand being pronated, the surgeon commences, at a point at the junction of the outer with the middle third of the back of the forearm, a little below the level of the wrist-joint, a convex incision, which reaches at its summit the middle of the dorsal surface of the thumb, and terminates in front, just below the palmar aspect of the wrist, at the junction of the outer with the middle thirds of the forearm. The flap, consisting of skin and fasciæ, having been raised, the two ends of its base are joined by an incision at a right angle to the long axis of the forearm. Finally, disarticulation is performed, beginning at the radial side. If needful, the flap may be taken from the hypothenar eminence, by reversing the incisions.

4. **Circular Amputation at Wrist.**—This method is only

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* *Précis d'Opérations de Chirurgie*, par le Dr. J. Chauvel, p. 171.

suited to patients with thin, lax skins, and even in them it is often difficult to raise quickly and neatly the skin, which is here adherent to some of the adjacent parts, as at the base of the hypothenar eminence. Moreover, cutting through these thin, lax skins may be followed by sloughing, especially if their vitality is impaired by sinuses, &c.

The hand being supported by an assistant, the surgeon draws up the skin of the forearm, and makes his first circular incision through the skin on a level with the carpo-metacarpal joints of the little finger and thumb, encroaching thus upon the thenar and hypothenar eminences, an inch or an inch and a quarter below the styloid processes. The skin being retracted by freeing the soft parts with light touches of the knife, another circular sweep is made just above the level of the pisiform bone, so as to sever cleanly the numerous tendons, together with the vessels and nerves. The joint is then opened, and the styloid processes removed.

5. **Amputation of Wrist by Long Dorsal Flap.**—This method on Mr. Teale's principle is not to be recommended. If a skin-flap alone were taken, its poor vitality would probably end in sloughing; if the tendons are taken up as well, but little additional vascularity is gained, while the flap is inevitably somewhat ragged. If this method has to be employed, the convexity of the flap should lie over the centre of the metacarpals.

LIGATURE OF RADIAL ARTERY ON THE BACK OF THE WRIST* (Fig. 5).

GUIDE.—A line drawn from a point just internal to the apex of the styloid process to the back of the first interosseous space.

RELATIONS:— IN FRONT.

Skin, fasciæ; branches of superficial radial vein, and of radial and musculo-cutaneous nerves; fibro-fatty tissue beneath deep fascia.

Three extensor tendons of thumb.

Radial artery
on back of wrist.

OUTSIDE.	BEHIND.	INSIDE.
V. comes.	Styloid process; external lateral ligament; trapezium; carpal ligaments.	V. comes.

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* The so-called "tabatière anatomique," a triangular space bounded externally by the extensor ossis metacarpi and extensor primi internodii, internally by the extensor secundi internodii; its apex is formed by the meeting of these tendons, and its base by the lower edge of the posterior annular ligament or base of the radius.

Indications.—Few ; usually wounds, *e.g.*, by the slipping of a chisel, by breaking crockery, &c. In such cases both ends* would, of course, be secured, and the surgeon would examine as to injury to any of the extensor tendons (p. 23).

Operation.—The incision, 1½–2 inches long, may be in the above line or parallel with the tendons. In either case it should be over the lower part of the vessel, just before it dips between the heads of the first dorsal interosseous into the palm. It should be made lightly, so as not to damage the radial vein or, deeper down, the tendons. The radial vein being drawn aside with a blunt hook, and the deep fascia being carefully opened, the tendons are pulled out of the way and the artery separated from its veins. The ligature may be passed from either side. The artery lies deeper than would be expected, usually covered by fatty tissue. If the parts need relaxing, the hand should be hyper-extended. All injury to the closely contiguous tendon-sheaths must be avoided ; and, for the same reason, union of the wound without suppuration is particularly indicated here.

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* Mr. Butcher (*Operative Surgery*, p. 407) states that the distal end of the artery is, after the division of the vessel, difficult to find, owing to its tendency to retract.

CHAPTER III.

OPERATIONS ON THE FOREARM.

LIGATURE OF RADIAL IN THE FOREARM (Fig. 17).

In the upper two thirds the artery is sub-muscular ; in the lower third it is sub-fascial.

Line.—From the centre of the bend of the elbow (where the artery is given off opposite to the neck of the radius) to a point just internal to the styloid process of the radius.

Guide.—The above line, and the inner aspect of the supinator longus.

Relations :— In Front.

Skin, fasciæ, viz., superficial, deep, and another layer, varying in distinctness, which ties the radial to the supinator longus and pronator radii teres.
Branches of musculo-cutaneous nerve, especially below.
Superficialis volæ below.
Transverse branches of venæ comites.
Supinator longus overlapping.

Outside.

Supinator longus.
Radial nerve (middle third).
Vein.

Inside.

Pronator radii teres.
Flexor carpi radialis.
Vein.

Radial artery
in forearm.

Behind.

Biceps.
Supinator brevis.
Pronator radii teres.
Flexor sublimis digitorum.
Flexor longus pollicis.
Pronator quadratus.
Radius.

Indications.

(1) Wounds; stabs; cuts with glass, &c.

(2) Traumatic aneurism.

In these cases the limb having been rendered evascular by Esmarch's bandages, the surgeon opens the swelling, turns out the clot, and ligatures the artery above and below. If he prefers it, he may snip out the swelling and twist both ends of the artery. The first method is, on the whole, the most generally applicable.

(3) Punctured wounds of palmar arch. Ligature of the radial and ulnar is preferred by some, but I would refer my readers to the remarks at p. 20.

A. **Ligature in the Lower Third of the Forearm** (Fig. 17).—The hand being completely supinated and the wrist extended at first, the surgeon, seated comfortably, makes an incision, 2 inches long, midway between the tendons of the supinator longus and flexor carpi radialis, or (if there be much swelling) exactly in the line of the artery, going lightly* through the skin and subcutaneous tissue. A large branch of the radial vein, which is usually met with subcutaneous and just under the incision, is now drawn aside or divided between two ligatures. The deep fascia is slit up on a director, and the wrist now flexed to relax the parts. The artery being separated from the venæ comites,† the needle may be passed in either direction. Damage to any of the tendon-sheaths should be most carefully avoided.

B. **Ligature in the Middle Third of the Forearm.**

Guide.—Line of artery, p. 39.

Relations, p. 39. The nerve is now on the outer side of the artery, but not very close to it.

The steps are very much as above, but the artery is lying deeper. The incision over the middle third of the artery should be fully 2 inches long, the parts well relaxed when the deep fascia is opened, the inner aspect of the supinator longus is next defined, and this muscle drawn well outwards. The layer of fascia which unites the artery to the supinator and pronator must now be opened. The needle should be passed from without inwards.

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* So as to avoid the radial vein, which always, and the superficialis volæ, which sometimes, lie superficial here, just under the deep fascia, which is very thin. On the dead subject, especially, it is easy for the student to get down to or below the artery with his first incision.

† These, owing to the free collateral venous currents, may be tied in if it is found very difficult to separate them from the artery.

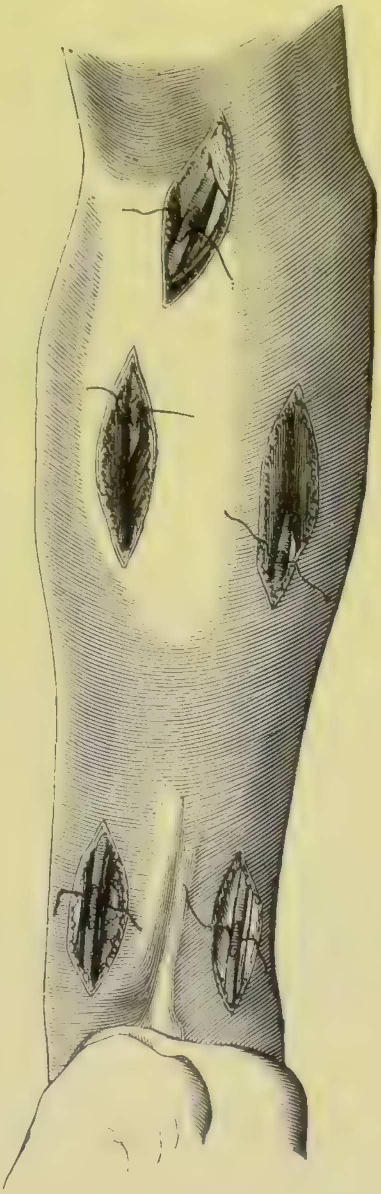
C. Ligature in the Upper Third of the Forearm (Fig. 17).

GUIDE.—Line of artery, and inner aspect of supinator longus.

RELATIONS, p. 39. The nerve is on the outer side, but well removed from the artery. The vessel itself lies somewhat obliquely as it passes from the middle of the elbow triangle to the outer side of the forearm.

In a muscular arm it is very easy to get into difficulties by not hitting off the right intermuscular septum, and thus getting too near the middle line of the forearm, unless the line of the artery is remembered. An incision, at least 2½ inches long, is made over the upper third of the artery, in the above line. Any branches of the radial vein are drawn out of the way, and secured with catgut ligatures. The deep fascia is slit up to the full extent of the wound, along a white line which marks the interval between the supinator longus and pronator radii teres. These muscles may be known by the direction of their respective fibres (Fig. 17), the former going straight down along the radius, and the latter obliquely downwards and outwards to the centre of this bone. The muscles being relaxed by bending the elbow and wrist joints, and the cellular interval between them having been opened cleanly with a director, they are drawn aside with blunt hooks, and the pulsation of the vessel felt for. The venæ comites having been separated, the needle may be passed from without inwards.

FIG. 17.



In the upper drawing ligature of the brachial in front of the elbow is shown. The biceps tendon is outside the artery, giving off in the upper angle of the wound the bicipital fascia; along the inner border of the wound lies the median nerve.

The remaining drawings show ligature of the radial and ulnar. In the lower two figures too much of the arteries is shown.

LIGATURE OF ULNAR ARTERY IN THE FOREARM (Fig. 17).

LINE.—As this artery takes a very oblique course inwards to the ulnar border of the forearm before it runs down parallel with this border to the wrist, the surface-marking for the lower two thirds of the vessel will be a line drawn from the front of the internal condyle to the outer side of the pisiform bone.

GUIDE.—The above line, and, in the lower third, the outer aspect of the flexor carpi ulnaris.

RELATIONS IN FOREARM :—

IN FRONT.

Skin ; superficial and deep fasciæ.
Branches of internal cutaneous, ulnar cutaneous nerve, and anterior ulnar vein.
Median nerve.
Pronator radii teres.
Flexor carpi radialis.
Palmaris longus.
Flexor digitorum sublimis.

OUTSIDE.	INSIDE.
Flexor digitorum sublimis.	Flexor carpi ulnaris.
Vein.	Ulnar nerve.
	Vein.

Ulnar artery
in forearm.

BEHIND.

Brachialis anticus.
Flexor profundus digitorum.

Indications.—These are the same as for the radial, p. 40.

Ligature in the Lower Third of the Forearm (Fig. 17).—Position of hand supinated, to begin with. An incision, 2 inches long, is made, lightly at first, along the outer border of the flexor carpi ulnaris, the superficial veins avoided, and the deep fascia opened. The wrist is then flexed, the flexor carpi ulnaris drawn gently inwards, the veins separated from the artery, if possible, and the ligature passed from within outwards away from the nerve. Care is to be taken to avoid opening the sheaths of the tendons.

Ligature in the Middle Third[*] of the Forearm (Fig. 17).—The position of the limb being as before, an incision, quite 3 inches long in a muscular arm, is made in the above given line of the artery over its middle third. Any superficial veins being drawn aside or secured with double ligatures, and the wound sponged dry, a white line,[†] which indicates the intermuscular septum between the flexor carpi ulnaris and the flexor sublimis, is looked for. If the incision is not directly over this, the edges of the superficial wound may be carefully cleared a little to one side or the other till the septum is found, or, with the finger-tip, the sulcus between the above muscles may be sought for. The deep fascia having been slit up to the full length of the wound on a director, a muscular branch which will serve as a guide to the artery will often be found coming up in the intermuscular space. The cellular tissue here being carefully torn through, the muscles are relaxed by bending the wrist and elbow; retractors are now introduced well into the wound, this sponged dry, and the artery looked for. The nerve which lies to the inner side, and which joins the artery at the junction of the middle and upper thirds of the forearm, may be seen first. The artery being cleaned, and the venæ comites separated from it, the ligature is passed from within outwards.

This is the only ligature in the forearm which will give trouble in the dead subject owing to the depth, and, sometimes, the difficulty of hitting off the intermuscular septum. Being frequently set as an examination test, the operation should be carefully studied by those at work on the dead body.

Difficulties and Mistakes.

1. Depth of the vessel in a well-developed limb.
2. Making the incision too short, or too much to the inner or the outer side, and thus finding a wrong septum, *e.g.*, one between the flexor carpi ulnaris and the flexor digitorum profundus, or that between the flexor digitorum sublimis and the palmaris longus.

Aids.

1. Keeping carefully to the above-given line.
2. Hitting off the right intermuscular septum and corresponding sulcus.

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[*] The artery is only ligatured in its upper third for wounds; it is necessary to remember the course of the vessel—oblique from without inwards—and to divide sufficiently the superficial flexors which lie over it.

[†] This line may be wanting. It is often but little marked, and occasionally fatty, in the bodies of the aged.

3. Finding a muscular branch, and using it as a guide to the artery.

If a wrong space is much opened up in the living subject, the contiguous muscles should be brought together with chromic catgut sutures cut short, due drainage being provided.

EXCISION OF RADIUS OR ULNA.

Indications.—(1) Sequestra; (2) Compound fractures; (3) New growths, especially myeloid. It is only in the last class of cases that any special difficulty will occur, and it is to these, accordingly, that the following account applies.

Operation for Removal of Radius.—This is the bone of the forearm in which myeloid sarcomata usually originate. The following is taken from a most successful case by Mr. H. Morris,* in which he removed the radius and ulna extensively, for a myeloid growth originating in the former, and firmly attaching the ulna to it. Esmarch's bandage being applied, a long incision was made over the outer side of the radius, from the styloid process to the upper third. The radial nerve was used as a guide to the interval between the supinator longus and extensor carpi radialis longior, Mr. Morris having found on the dead subject that he could most readily separate the soft structures from the front and back of the radius by going between those muscles, and keeping the supinator to the fore part of the incision. The supinator longus and pronator teres at their insertions being detached from the radius, the bone, when freed of its muscles in front and behind, was sawn through at the lower edge of the supinator brevis. A second longitudinal incision, of less extent than the first, was made along the inner side of the ulna from the wrist-joint upwards, and through it the rest of the soft parts separated from the tumour and ulna. This bone was sawn between 3 and 4 inches above the wrist, and the lower ends of both bones disarticulated by opening the wrist-joint on the inner side. The entire tumour, with the ulna and pronator quadratus, was then removed *en masse*. The anterior interosseous artery was divided just above the pronator quadratus, but no other large branches were injured. The wounds healed in about seven weeks. As soon as a light leather splint was moulded on to the forearm and wrist, the usefulness of the hand steadily increased. Four years later Mr. Morris brought the patient before the Clinical Society

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* *Clin. Soc. Trans.*, vol. x. p. 138.

(*Trans.*, vol. xiii. p. 155, pl. vi.). There was no recurrence. By the aid of a leather splint, the patient was able to nurse, dress, carry, and wash and care for her children, do her household work, and wash the house-linen. She could also stitch and darn, and pick up a pin. Latterly, since contraction had taken place, she could hold her hand out straight without any support.*

Operation for Removal of Ulna.—In the very much rarer cases of myeloid tumours springing from the ulna, the following may be the course adopted. The account is taken from a paper by Mr. Lucas (*Clin. Soc. Trans.*, vol. x. p. 135). A longitudinal incision, about 4 inches long, exposed the tumour between the flexor and extensor carpi ulnaris. In making this the dorsal branch of the ulnar nerve was divided. The soft parts being next retracted, the bone was exposed above the level of the tumour, and sawn through. The piece connected with the tumour was next drawn out of the wound, while the interosseous membrane was divided, and the extensor indicis on the posterior and the pronator quadratus on the anterior separated from the tumour. The removal was completed by dividing the ligaments of the lower radio-ulnar joint, the attachment of the triangular fibro-cartilage to the ulna and the internal lateral ligament. The patient left the hospital in five weeks, the resulting usefulness being excellent.

Excision of Radius and Ulna in Military Surgery.—By this is meant deliberate removal of portions of these bones damaged by gunshot or other injuries, not the mere picking away of spicula and fragments.

Dr. Otis† divides the cases into the three groups of primary, intermediary (before the thirtieth day), and secondary (after the thirtieth day). Though caries and attempt at repair were met with in these latter cases, there was no time for invagination of sequestra. Thus they were very different from necrosis operations, and hence, in great measure, the high mortality. Of the primary 10 per cent., of the intermediary 19 per cent., ended fatally; the mortality of the secondary was nearly as high as that of the primary excisions.

The concluding observations of Dr. Otis are worthy of the most careful attention of military and naval surgeons.

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* After these operations, as in any in which the flexors and extensors of the fingers must, of necessity, be meddled with, passive movement of the fingers should be commenced very early, and energetically persevered with.

† *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 935 *et seq.*

"Of this large number of excisions in the continuity of the forearm there is little to remark save that, in the aggregate, the mortality of shot fractures of the bones of the forearm appears to have been sensibly augmented by operative interference, and that I have sought in vain for a single instance in which a formal excision of a portion of the shaft of either radius or ulna had a really satisfactory result as regards the functional utility of the limb. The representations of Baudens of his Algerian experience led the German surgeons to practise these excisions in the shafts of long bones to some extent in the Danish and Austrian campaigns, with very unsatisfactory results. Similar operations were resorted to with comparative frequency during the American War, and the results plainly indicate, I think, that formal primary operations of this nature should be banished from the practice of military surgery. It is bad enough to remove adherent primary sequestra, for our museum abounds in examples where such fragments have retained their vitality, and maintained the continuity of long bones; it is worse to deliberately remove unoffending healthy portions of the bone. The mortality, greatly exceeding that of the expectant conservative treatment, the numerous consecutive amputations, and the large proportion of hopelessly deformed limbs sufficiently condemn such operations. I have found nothing in the reports of the surgery of the late Franco-German War that was not conformable to these conclusions."

Sir T. Longmore* brings the following striking experience to bear on these cases:—"I have seen many of these fractures in which primary resection of a portion of the entire shaft by a shot has occurred, and have not met with bony union in any case where the gap was a full inch in amount."

Causes of these Resections doing Ill or Failing.

1. Osteo-myelitis.
2. Pyæmia.
3. Hectic.
4. Hæmorrhage.
5. Painful irritable cicatrices.
6. Non-union. False joint. Flail-like limb.
7. Displacement of the hand at the wrist.
8. Permanent contraction of flexor or extensor tendons.

AMPUTATION OF FOREARM (Figs. 18, 19, 20).

Practical Anatomical Points.—In this frequently performed operation the following should be kept in view:—

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* *Syst. of Surg.*, vol. i. p. 544.

(*α*) The two bones are not fixed, like those in the leg, but movable. This mobility may prevent their being parallel when the knife is sent across in transfixion, and thus lead to penetration of the interosseous membrane; it must also be remembered in sawing the bones. Lastly, on this mobility in pronation and supination depends the usefulness of the stump, which must therefore be left as long as possible, the bones being always, when practicable, sawn well below the insertion of the pronator radii teres into the middle of the outer surface of the radius.

(*β*) In the upper part of the forearm, both in front and behind, are fleshy bellies; below, the soft parts are increasingly tendinous. Furthermore, the anterior border of the radius and the posterior of the ulna, especially the latter, are largely subcutaneous.

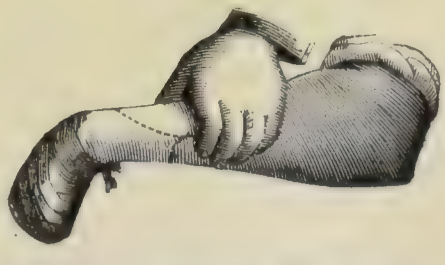
Different Methods.

1. Skin flaps, antero-posterior or lateral, with circular division of muscles, &c.
2. Transfixion flaps.
3. Circular.
4. Teale's.

1. **Amputation of Forearm by Skin Flaps, with Circular Division of Muscles, &c.** (Figs. 18, 19).—While, in an amputation so often called for, it is well to practise several methods, none, on the whole, answers so well as this, for the following reasons:—(*a*) By cutting one flap a little longer than the other, sufficient skin can always be obtained to give a good stump. (*β*) Transfixion, while quite unsuited to the lower third, owing to the numerous tendons, can only be performed in the upper third in moderately muscular forearms with ultimate satisfaction. For in a bulky, fleshy limb (as in a case of accident in a male adult) it is not easy always to cut the skin longer than the muscles in bringing out the knife, and so to prevent the tendency of the fleshy bellies to protrude while the flaps are being united; and a little later, these muscles, with large surfaces cut obliquely, give rise to a good deal of blood-stained oozing, which is very likely to cause tension, suppuration, and delay in healing.

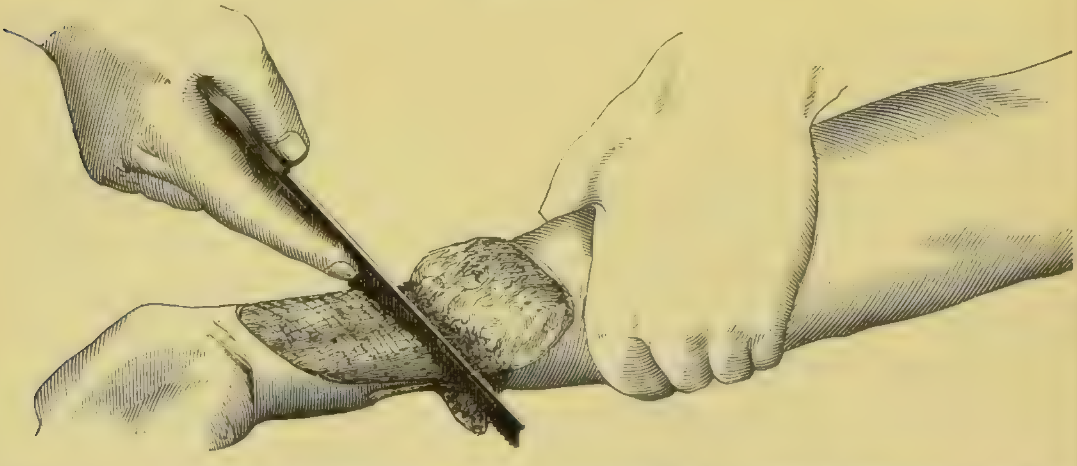
The brachial being secured with an Esmarch's bandage, the arm extended from the side, with the forearm pronated and the hand steadied by an assistant, the surgeon, standing outside the limb on the right, and inside it in the case of the left side, places his left index and thumb on the borders of the radius and ulna, at the spot where he intends to saw the

FIG. 18.



bones (Fig. 18). The point of a narrow-bladed knife (about 4 inches long), or a small catlin, is then inserted just below the index, carried along the bone for 3 inches, then curved suddenly across, so as to mark out a broad arched, not a pointed, flap

FIG. 19.



(Fig. 19), and finally carried up along the bone nearest to the surgeon to a point just below the thumb.

This flap is then dissected up without scoring, consisting of skin and fasciæ.* The forearm is next raised by the assistant holding the hand, so that its palmar aspect faces the surgeon,† who marks out, by a curved cut joining the two horns of the other incision, a similar flap on the anterior surface, but one only about 2 inches in length. This flap being raised and both retracted, the soft parts are divided with a circular sweep close to the base of the flaps, this being repeated once or twice till the bones are quite exposed. The knife is then passed, with due care of the severed arteries, between the bones, so as to divide the interosseous membrane, and the periosteum next circularly cut where the saw is to pass. The bones are then sawn through, with the following precautions:—The heel being placed on the bones, it is drawn lightly, but firmly, towards the operator two or three times, so as to make a groove. With a series of light sweeps, in which the whole length of the saw is used, the two bones are then cut through together,‡ the limb being kept supinated during the use of the saw, so as to keep the bones as parallel as possible.

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* The under surface of a so-called skin flap should always, when possible, show a few muscular fibres; this shows that the deep fascia is present, in which the vessels run down to send up branches to supply the skin.

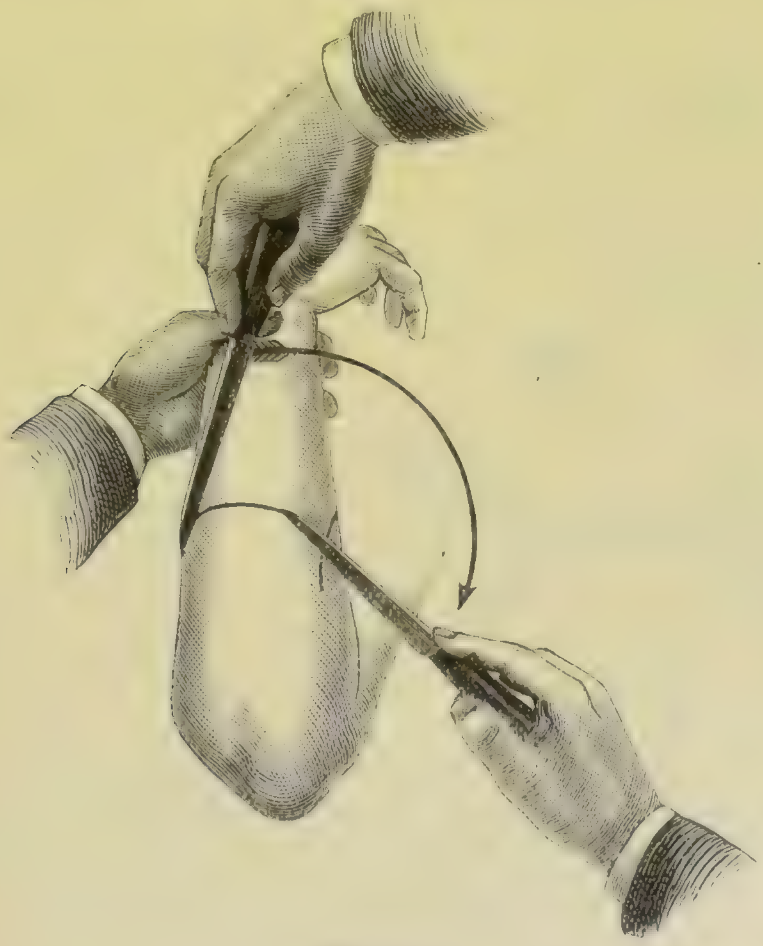
† Care must be taken to keep the bones parallel, now, and throughout the operation.

‡ Some advise that the more movable radius should be divided before the section of the ulna is completed. If the saw is used lightly and swiftly, both bones will be sawn simultaneously. The student usually commits these faults in

The assistant in charge of the lower part of the limb must be most careful to hold it steady: if he depress at all, the bones will certainly splinter when half sawn through; if, on the other hand, he raise the parts, the saw will be locked.

Any tendons requiring it are then trimmed, nerves cut short and square, and the vessels ligatured or twisted. These are usually four—viz., the radial, under cover of the supinator longus, close to its bone; the ulnar, covered by the flexor carpi ulnaris, on the front of the ulna. Their respective nerves are good guides to the arteries, save quite low down, when the radial has gone to the back of the limb. The anterior interosseous is found on the front of the interosseous membrane, and the posterior interosseous between the deep and superficial extensors.

FIG. 20.



(Farabeuf.)

If the surgeon prefer it, instead of having the forearm raised so as to face him (Fig. 20) while he shapes the flap from the

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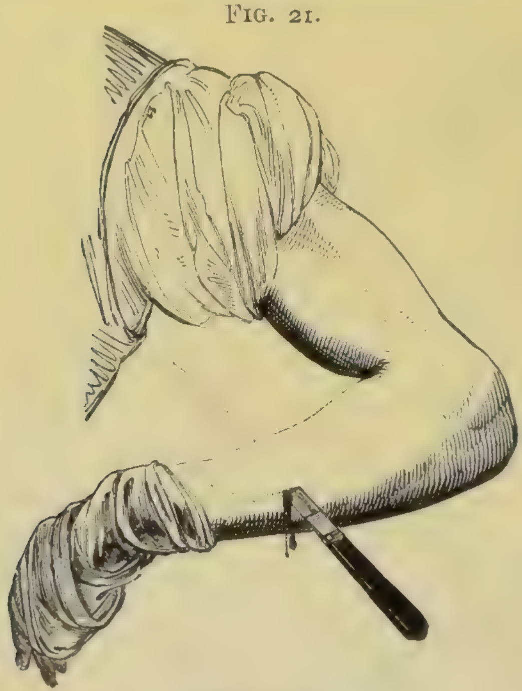
the use of the saw—he bears too heavily on it, thus locking it or fracturing the bone, and he makes but short sweeps, using half of the instrument only.

anterior or flexor surface, he will tell the assistant to completely supinate the forearm, and proceed to make the flap with the limb in this position.

If, owing to the condition of the soft parts, lateral flaps are preferred, the limb being pronated, the surgeon marks the site of bone-section with his left forefinger and thumb placed on the extensor and flexor aspects of the limb at this level. Then, looking over the forearm, he enters his knife in the centre of the flexor surface, and carries it, cutting a broadly arched flap, about 2½ inches long, to a corresponding point on the centre of the back of the limb, and then from this point down again over the side nearest to him, to the spot where the knife was first entered. The flaps are next dissected up with the precautions already given, and the operation completed as before.

2. **Amputation of Forearm by Transfixion Flaps** (Fig. 21).—In the case of a moderately muscular forearm the surgeon may make use of this method in amputating through the middle of the forearm. For reasons already given (p. 47), this method is not recommended, but the rapidity with which it can be done recommends it to the notice of those who may have to treat wounded in war on a large scale, or railway accidents where more than one limb requires amputation. The limb being abducted, and the forearm supported and pronated, with the bones as parallel as possible, the surgeon, standing outside the right and inside the left limb, lifts up the soft parts* at the spot where he intends to saw the bones, and sends a narrow-bladed knife (4 to 5 inches long) across the limb, entering it, and bringing it out just above the bones. He then, by cutting downwards and forwards, shapes as broad a flap as possible with a steady sawing movement, taking care, before bringing out the knife, to cut the skin longer than the muscles by continuing the use of the knife after the latter are felt to be

FIG. 21.



(Fergusson.)

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[*] This step is most useful—in fact, essential. It is often forgotten.

cut through. The flap should be 3 to 4 inches long according to the condition of the tissues on the other side, each flap being made as broad as possible and bluntly rounded as it is finished.

The tissues on the front are then lifted from the bones and transfixed by passing the knife across immediately above the bones at the base of the first-made flap, the limb being now supinated. As in this second transfixion the skin on the farther side of the limb may be punctured, it is well for the surgeon to hold down its cut edge with a finger. The second flap is then cut, broad, well-rounded, and 2½ to 3 inches long according to the length of the anterior. The flaps are then retracted, the soft parts severed with a circular sweep, the interosseous membrane divided, and the rest of the operation completed as in the method first described (p. 48). If this method is used the nerves should always be cut short and square ; otherwise painful bulbous ends may follow.

A very rapid and effective modification of the above is the following :—As, owing to the inequality of the soft parts on the back as compared with those on the front of the forearm, and also from the proximity of the ulna to the surface here, transfixion of a dorsal flap is not always easy, a quicker method is as follows. A skin flap, 3½ inches long, broad and well rounded, being marked out on the posterior aspect of the limb, the knife is immediately, without being taken off, pushed across in front of the bones and made to cut a flap, by transfixion, 2½ inches long, the skin being cut longer than the muscles (p. 50). The dorsal skin flap is then dissected up, the flaps retracted, and the bones cleared as before.

3. **Amputation of the Forearm by the Circular Method.**—This method is not recommended here owing to the flat shape of the limb and the adhesion of the deep fascia above to the muscles. It is best suited to amputation in the lower third. It may be performed as follows :—The surgeon, standing outside the limb, which is kept supinated, having drawn the skin well upwards, passes a knife under the forearm, then above, and so around it till, by dropping the point vertically, the back of the knife looks towards him, and its heel is resting on the part of the forearm which is nearest to him. An incision is then made circularly through skin, superficial and deep fasciæ,* round the whole circumference of the limb 2½ inches below the point where

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* If, in raising the cuff-like flap, muscular fibres are seen on the under surface, the presence of the deep fascia and, thus, a better blood-supply will be assured than by the quicker method of simply peeling the skin and subcutaneous tissue off the deep fascia.

the bones are to be sawn. The completion of this circular sweep is aided by the assistant in charge of the limb rotating it so as to make the tissues meet the knife.

A circular flap of tissues having been turned back as high as the point of bone section, a second and much firmer circular sweep is here made through everything down to the bones, this being repeated till all the soft parts are cut clean and square. If there is any doubt about the sufficiency of coverings to the bones, the soft parts around these may be freed a little higher (care being taken not to prick the radial or ulnar); the soft parts are then vigorously and firmly retracted, and the bones sawn through, with the precautions given at p. 48.

CHAPTER IV.

OPERATIONS IN THE NEIGHBOURHOOD OF THE ELBOW-JOINT.

AMPUTATION AT ELBOW-JOINT (Fig. 22).

THIS operation gives excellent results, good flaps being obtainable from the thick soft parts in front and from the skin behind, which is well used to pressure. Furthermore, there are no bones to saw.

It has not been performed as often as it might have been, owing, perhaps, to the belief which some surgeons have held that cartilaginous surfaces left in a wound are a source of delay in healing, an opinion no longer of importance in antiseptic surgery; from the fact that any disarticulation, however simple, is considered to complicate an amputation; and because, owing to the expanded end of the humerus, the resulting wound is somewhat larger than in amputation through the lower third of the humerus.

Practical Points.

(*a*) The internal condyle is nearly ½ inch below the level of the external.

(β) The joint is opened most easily on the outer side.

(γ) There are masses of muscles on the front and sides; of the latter, those on the outer side (owing to the presence of the supinator longus) retract more powerfully than those on the inner.

(δ) The skin on the back of the joint is well used to pressure, and is connected by fibrous bands to the back of the ulna.

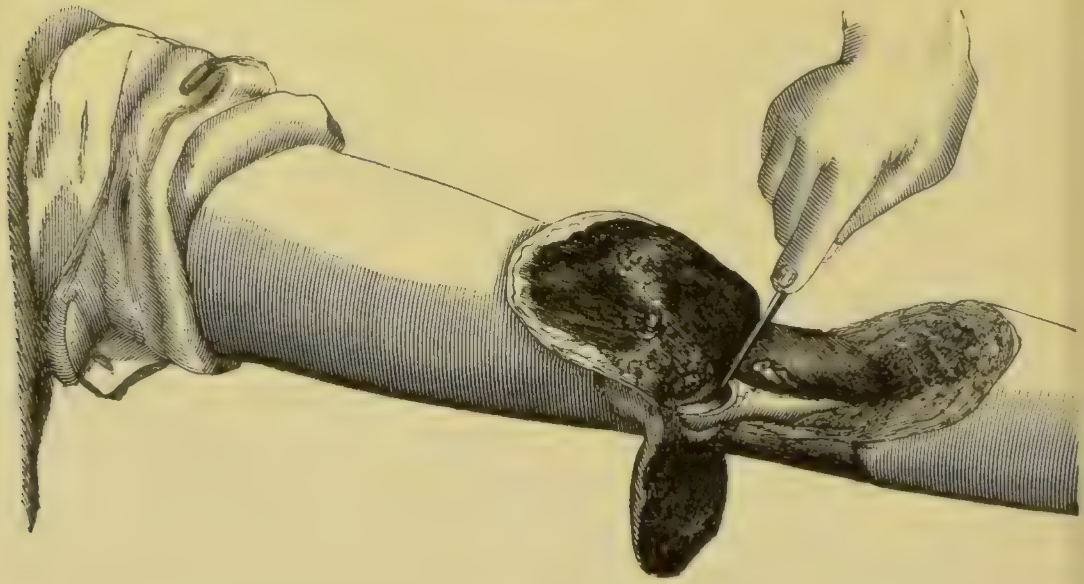
Methods.—Owing to the vascularity of the parts, any of the following may be made use of. I would advise the student to practise the first especially.

i. Long anterior flap with short posterior (Fig. 22).
ii. Lateral skin flaps, or a single lateral flap.
iii. Circular.
iv. Long posterior flap.
v. Long anterior flap.

i. **Long Anterior Flap (usually by Transfixion), with Short Posterior Flap** (Fig. 22).—This method gives an excellent covering to the front of the humerus, allows of easy drainage, and preserves skin which is well used to pressure.

The brachial being controlled a little above its centre,* the forearm being held somewhat flexed and completely supinated, the surgeon, standing on the inner side in the case of the left, and outside the right limb, raises the soft parts in front of the elbow triangle, and sends his knife, held horizontally, across, just in front of the joint. Thus, entering it an inch below the internal condyle, and bringing it out 1½ inch below the external one, or *vice versâ*, he cuts a well-rounded flap, 3 inches long, taking care, as the knife emerges, that the skin is cut longer than the muscles. Then, passing his knife behind the limb, and looking over, the surgeon joins the two ends of the base of his first incision by a convex cut through the skin over the back of the olecranon, so as to mark out a flap 1½ inch long. This is raised without scoring, care being taken to keep the knife towards the ulna, for fear of "button-holes." The two flaps being then held back, any remaining structures in front are severed, the joint first opened on the outer side, and the forearm removed by dividing the lateral ligaments and triceps.†

FIG. 22.



Amputation through the elbow-joint by anterior and posterior flaps, at the moment of disarticulation.

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* The assistant who has charge of the Esmarch's bandage, and who is steadying the arm, should draw the skin on the back of the elbow-joint somewhat upwards.

† In Fig. 22 by mistake, the operator has been shown commencing disarti-

During the last steps the assistant in charge of the forearm pulls this away from the arm.

The brachial artery is next secured, together with any other vessels which continue to bleed on removal of the Esmarch's bandage. Any nerves which require it are then cut short, a drainage-tube inserted, and the flaps carefully united.

Modifications of the Above.—The flaps can be cut of different lengths, according to the state of the soft parts. If the surgeon prefer to do so, he can cut his anterior flap from without inwards instead of by transfixion, a course which may well be adopted in an unusually bulky, muscular limb. The posterior flap can be made by cutting from within outwards, after disarticulation, but this, while quicker, is usually less preferable.

ii. **Amputation by Lateral Skin Flaps, or by one Lateral Flap.**—The advantages of this method are, that it is very easily done, and that, if more skin is available on one side than on the other, flaps unequal in length can readily be made. If the surgeon amputate by equal lateral flaps—standing as before, and having his left index finger on the centre of the elbow triangle and left thumb at the corresponding point behind, he looks over, and enters his knife close to his thumb, and marks out, on the side farthest from him, a flap well rounded, and about 2½ or 3 inches long, reaching to the finger in front. He then marks out a corresponding flap from this point, on the side nearest to him, to that where he began. These flaps are then dissected up of skin and fasciæ as thick as possible, the soft parts severed with a circular sweep, and disarticulation performed, beginning at the outer side.

iii. **Circular Method.**—The surgeon, standing as before, makes a circular incision round the forearm, 2½ or 3 inches below the joint, going through skin and fasciæ. A cuff of skin is then turned back as far up as the joint, the muscles severed with one or two firm sweeps, the lateral ligaments divided, and disarticulation performed as before. The edges of the wound may be united either horizontally, or vertically from above downwards.

EXCISION OF ELBOW (Figs. 23, 24, 25).

Practical Points.—These bear upon the success of this operation.

(1) It is a comparatively simple joint, with small articular

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culation on the inner instead of on the outer side, which is usually the easier. The flaps also are rather too long. For these errors I alone am responsible.

surfaces readily got at. (2) Its synovial membrane is simple. (3) Its vascular supply is abundant. (4) The surrounding muscles are powerful, ensuring, if they regain firm attachment, excellent mobility. From the above, and from the untoward effects of ankylosis, a natural cure in the elbow is often not so useful as that given by excision. This operation should be performed oftener, especially in the first six of the following conditions.

Indications.

1. Pulpy disease. Where this has resisted treatment in a patient who shows no sign of tuberculosis, lardaceous disease, &c., where it is the only large joint affected, and where the powers of repair are sufficient. If treatment fails to promise a movable joint, there is no good losing more time; the muscles will only be more wasted, sinuses will only form more extensively, and the patient's health be more impaired.

2. Injury and its results. (A) *Primary excision.* When the joint is much opened, the cartilages much damaged, when the shaft is intact and the tissues in front are sound. (B) *Secondary excision.* When acute arthritis, not yielding to incision and drainage of the joint, has followed on an injury, and ankylosis is the best result which can be hoped for without operation. In such cases, as the inflamed condition of the bones and soft parts may produce septic cellulitis and osteo-myelitis after an operation, it will be wiser, before excising, to wait till the inflammation has somewhat subsided. It must be remembered that, in excision after injury, reaction will probably be greater, suppuration more certain, and a tendency to bony ankylosis more marked, especially if the periosteum is preserved. Sufficient drainage is absolutely needful.

3. Ankylosis in a faulty position. When this, as the result of injury or disease, whether bony or densely fibrous, renders the limb useless. In deciding whether to excise for ankylosis, the surgeon should make out how far the limb is really useless, whether there are any cicatricial bands, especially in front, and whether the wasting of the muscles is very marked, for these may be so long and so utterly atrophied that the limb may be but little more useful after operation.

4. Osteo-arthritis. If the patient is healthy, not advanced in years—*i.e.*, not much over forty, and not broken down—and if this is the only joint attacked. The surgeon must be prepared for sawing very dense bones here.

5. Disorganizing arthritis of elbow after pyæmia or rheumatic fever.

6. Unreduced dislocation or fracture causing pressure on the nerve-trunks near the elbow, especially if the patient is young, and the limb useless.

Rarer Indications.

7. Mr. Annandale (*Lancet*, 1879, vol. i. p. 256) has excised the elbow two or three times in cases of extensive sores on the back of the joint in order to allow the sore to close by removing the bones beneath, and to ensure movement.

8. The same surgeon excised, with an excellent result, where a dense scar had formed, drawing up the forearm and fixing the joint.

9. For growths of the bones, especially if innocent and affecting one bone—*e.g.*, exostosis.

The following points call for consideration in any case where excision of the elbow is being discussed:—

1. *Age.*—This must always have much influence. In very young children due attention must be paid to the naturally great power of repair. After thirty-five or forty the surgeon should weigh very carefully all the points of the case, and only excise where all else is favourable. From puberty* to thirty-five I consider the best age.

2. *Complications.*—These are most likely to present themselves in the shape of diseases of other bones and joints, for such a complication as phthisis calls for amputation. Caries of the metacarpal or metatarsal bones is not of itself a contra-indication. If a diseased spine is present, the question of excision will depend on whether the vertebral caries is old, or recent and active. If old, is the elbow a source of much irritation? Two large joints are rarely diseased at the same time. Mr. Holmes (*Clin. Soc. Trans.*, vol. i. p. 143) records a case of a boy aged five where he excised, with excellent result, both elbow-joints, only a few weeks intervening between the two operations.

Mr. Clement Lucas (*Brit. Med. Journ.*, 1881, vol. ii. p. 897) relates a case in which disease of the left elbow came on about two years after excision of the right joint, and was also successfully operated on. Since 1886 I have excised the elbow-joint with good result in four children, in whom some years before I had successfully excised a knee-joint.

3. *Question of the Value of Preserving the Periosteum.*—While the periosteum may be easily preserved in cases where it is swollen

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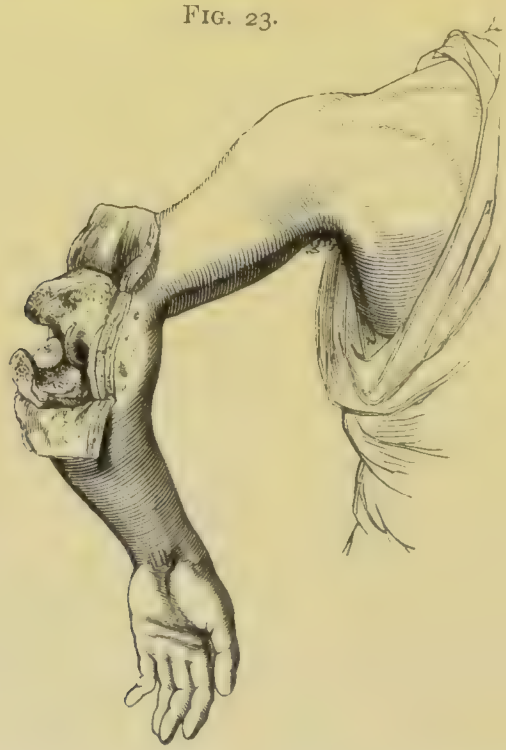
* As is stated below (p. 62), young children are not satisfactory subjects for after-treatment and movement. Mr. Annandale (*loc. supra cit.*) has excised successfully in patients aged three and seventy-five. No details are however given.

and loose, its preservation is in others a matter of very great difficulty, rendering the operation much more laborious and prolonged, and it is extremely doubtful if its advantages are equivalent in this joint, where the ordinary operation gives such excellent results. Some cases—*e.g.*, primary excision for injury—are unsuited to this method, as the periosteum is unaltered. In strumous disease it is often unsuitable, on account of the risk of leaving pulpy mischief behind.

Sub-periosteal resection is said to lead to less hæmorrhage, less disturbance of the capsule and attachments of muscles, and greater completeness of the new joint. While the last of these is undoubted,* it may bring about impaired movement,† and I am of opinion that the surgeon should only trouble to preserve the

FIG. 23.



Excision of the elbow by the H-shaped incision. The thickened soft parts, the sinuses, the carious ends of the bones, together with the position of the ulnar nerve, are admirably shown. (Fergusson.)

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* In one case Langenbeck (*Arch.*, vol. viii. p. 136; *Syd. Soc. Bien. Retr.*, 1867–8, p. 265) had "to treat a dropsy of the new elbow-joint by painting with iodine, and ultimately by the plaster-of-Paris bandage."

† A case is given (Langenbeck, *loc. supra cit.*) in which, after sub-periosteal resection, the condyles had been very perfectly reproduced, and the olecranon had been re-formed to even an inconvenient extent, for it was so long and curved as somewhat to limit extension. This method should usually be rejected in children, and also in cases of ankylosis, for fear of a recurrence.

periosteum in cases where an unusually large amount of bone has to be removed. Whenever the periosteum is preserved, passive movement should be begun early.

Operation.—The single vertical incision at the back gives such excellent results that this only will be described. The H-shaped incision, while giving more free exposure and rendering the operation more easy, has the serious disadvantage of damaging the insertion of the triceps, and of leaving additional scars, which may hamper the movement of the new joint. Any transverse incision should only be added to the longitudinal when the parts are extremely fixed and thickened. Lateral incisions interfere with the blood-supply, and give much less satisfactory access to the joint. The bayonet incision of M. Ollier, with its upper part along the external supra-condyloid ridge, its centre passing obliquely across the olecranon, and its lower part running along the inner border of that process, though stated by Sir W. Maccormac "to sacrifice neither muscle nor tendon," must surely in ordinary hands damage the very important outer lateral process of the triceps continuous with the fascia over the anconeus. The single posterior incision is said by some surgeons (*e.g.*, Farabeuf) to be unsuited for cases ankylosed at a right angle. But if the union cannot be broken down under the anæsthetic, it can be divided by careful use of saw or chisel, and the operation completed in the usual way. I have not found that this "exposes the neighbouring parts to great risk of injury," as stated by Sir W. Maccormac. Esmarch's bandage having been applied at mid-arm, or the whole limb being rendered evascular as far as the above point by the use of two bandages, a pillow is placed under the shoulder of the affected side, and the limb flexed and carried over the front of the trunk so as to present it fairly to the surgeon, who usually stands on the opposite side of the body.

The surgeon, then, noting the relative position of the condyles and the course of the ulnar nerve, makes a straight incision of sufficient length * (3 to 4 inches in the adult), with its centre at the tip of the olecranon, a little internal to the centre of the back of the joint, and parallel with the ulnar nerve. This incision should begin above or below as is most convenient, and go down to the bone throughout its whole extent, splitting the triceps muscle and tendon. Partly with the point of the knife, partly with an elevator or blunt dissector* (Fig. 24), the surgeon then raises, as far as possible in one piece and without tearing or jagging, the outer half of the triceps, which, with its expansion into the deep fascia of the forearm over the anconeus (this latter muscle being taken up at the same time), is peeled up as thickly as possible from its insertion into the ulna.

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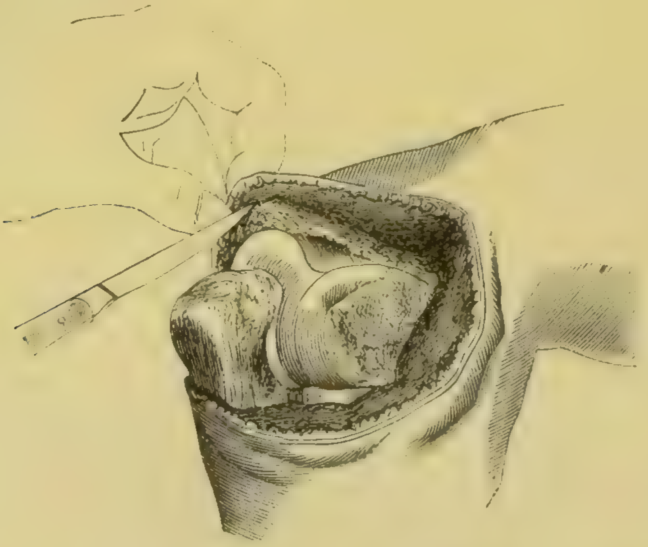
* An insufficient incision will only increase the difficulty of the operation, and, by the bruising then consequent upon the strenuous use of retractors, lead to suppuration.

FIG. 24.



To show the level to which the bones are to be cleared, and the way in which the thumb-nail is kept between the knife and the soft parts.

The deeper parts on the outer† side of the joint are then separated from the bones with the point of the knife and thumb-nail or blunt dissector, until the external condyle and head of the radius are completely exposed. The left thumb, all the time sunk deeply into the wound, pushes the flap of soft parts as it is detached, towards and over the external condyle. It is, finally, displaced over this, as the joint is flexed strongly. Next, the parts on the inner side should be detached from the inner condyle and inner border of the olecranon, great care being taken, by the following precautions, to keep intact the ulnar nerve:—(*a*) By keeping the knife parallel with the nerve and close to the bone; (*b*) By the use of the thumb-nail, which peels off the soft parts before the knife. By these means the soft parts will be satisfactorily cleared from the bones; retractors, well applied, will be found most useful, as the process of peeling off the soft parts is somewhat fatiguing to the thumb. This is especially the case in excision for accidents or on the dead body, and it is in these only that the nerve may be seen, though indistinctly. Where the parts have been long inflamed, they peel off much more readily, and the nerve is buried in the swelling.

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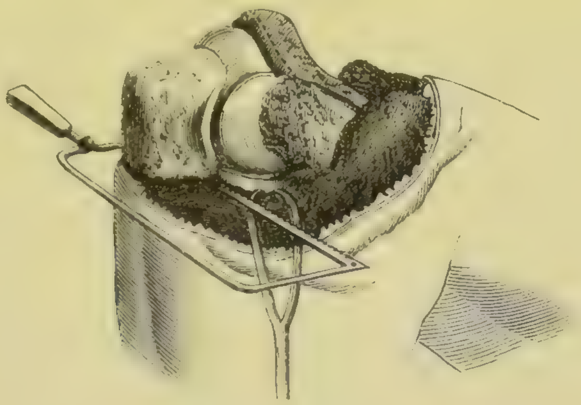
* The more readily the periosteum and soft parts separate, the more will the blunt instruments be used. As a rule, the use of the knife is called for.

† For the sake of practice, it is well to take the outer side first, before clearing the inner, with the ulnar nerve in proximity to it.

The joint is now strongly flexed, the lateral ligaments severed, and the capsule opened just above the olecranon ; the bone-ends are then turned out and prepared for the saw by passing the knife down to the bone, along the lines of intended section, the soft parts being well retracted beyond these lines.

SITE OF BONE SECTION.*—The ulna should be sawn (towards the joint with a small Butcher's saw set firmly) so as to remove the greater and lesser sigmoid cavities with the olecranon. The radius is removed at the same time just below its head, above the biceps. The section of the humerus should be through the base of the condyles, so as to remove all the articular cartilage. While the bones are sawn, the olecranon and trochlea of the humerus may be steadied in the grip of a lion forceps held vertically, the soft parts at the sides being well retracted. Any soft, caseous patches in the bone-ends are now gouged, any possible sequestra removed. In bad cases the bones are liable to be fatty, with little natural marrow ; such, however, are not necessarily irrecoverable. If the bone above the levels of section appears roughened, and the site of periostitis, this need not be touched ; all will probably subside when the cause of irritation is removed. Any sinuses should next be laid open, with due regard to the ulnar nerve, and their contents scraped out with sharp spoons. A zinc chloride

FIG. 25.



To show the application of the saw. The dotted line across the humerus shows that the saw should pass well above the articular cartilage.

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* See the remarks below on the amount of bone to be removed (p. 63).

solution (gr. x—ʒj) may be applied cautiously if there is any doubt about the parts being aseptic; but any solution stronger than this runs the risk of causing sloughing where the vitality of parts is low. One or two points of suture may, perhaps, be inserted, so as to close just the ends of the wound; but all the rest of this should be left open, and a drainage-tube inserted. If the parts are softened by inflammation, blistering, &c., or if it is a case of extensive disease, sutures had better not be used.* Very varied forms of splint have been advised.† Some surgeons, to keep the bones apart, from the first put the limb up on some form of right-angled splint; others, fearing a flail-like condition of the joint, prefer to begin with the arm and forearm on a straight splint, or on one with an obtuse angle (about 135°—Ashurst, *Encyclopædia of Surgery*, vol. iv. p. 477). As ankylosis is, in children especially, to be dreaded (*vide infra*), I prefer to put cases up from the first on a right-angled splint, using some such cheap form as that which I have described in the *British Medical Journal*, 1877, vol. i. p. 774, in which the anterior metal bar supports the limb, while it leaves the wound exposed and is easily kept clean, the movable hand-piece readily admitting of early passive pronation and supination.‡

Passive movement of the fingers and hand should be begun on the second or third day. The joint itself should be moved as soon as all irritation has subsided and the deeper part of the wound is well healed (about the tenth day). In children an anæsthetic may have to be given several times. The angle of the splint should be altered or the limb put up straight for a few days, and then flexed. Later on, weight-extension should be used, by securing a bag of shot, which is added to from day to day. Later, the sound limb may be fastened up, so that the child must use the excised joint. This getting children to use the joint is often most difficult, as friends are usually too foolish to see that the surgeon's directions are carried out daily, because they cause a little short, but most necessary, suffering. Parents are far too ready to think that because an operation has been performed, and the wound nearly, if not quite, healed, no more is necessary.* In commencing pronation and supination early, the ulna should be steadied while the hand and radius are very carefully moved. The first attempts at passive movement should be exceedingly gentle, and too much should not be attempted at first. Too vigorous or prolonged trials will only lead to irritation and the throwing out of inflammatory swelling, which will hamper movement seriously. When the parts are sufficiently consolidated, the splint may be left off and a sling substituted. Falls must be carefully avoided, and no liberties taken with the new union—*i.e.*, by a patient attempting to do too much with the limb, as in lifting.

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* Farabeuf (*Man. Opér.*, p. 710) points out that if, owing to long-existing disease of the elbow, the shoulder, wrist, or fingers are stiff, opportunity should now be taken to break down adhesions.

† By some surgeons a splint is here dispensed with. I strongly advise the use of one which is light and simple (*vide supra*), especially in children, as during the first two weeks, where a splint has been dispensed with, the bone-ends have been known to project from the wound.

‡ Mr. Heath's and Mr. Mason's splints are intended to aid in restoring the movements of the joint, while they also separate the ends of the bones. Prof. Esmarch's double-bracketed splint, Prof. Butcher's box splint, and Prof. Volkmann's wire splint (based on that for the lower extremity of Prof. Nathan Smith) have all been highly spoken of in military surgery.

AMOUNT OF BONE TO BE REMOVED.—This should be, roughly speaking, all the articular cartilages,† including about 1½ inch from the humerus, and the same from the ulna, the radius being sawn through just below its articular head. In cases of ankylosis,‡ most bone must be removed from the humerus, that from the bones of the forearm being limited by attachment of important muscles. Mr. Annandale (*loc. supra cit.*) considers that an interval of 1½ inch should intervene between the bones after the sawn sections have been made, and the bones placed in the position of extension. Certainly, no locking whatever should take place; 1½ inch interval is probably the full amount, an interval of 2 inches being liable to lead to "flail union." §

Mr. Holmes has pointed out long ago that if, after removing as much bone as is wise, disease is still felt on the anterior surface —*e.g.*, of the ulna—it is not necessary to make further sections in order to get beyond it; scraping will be sufficient, and save any further interference with attachment of muscles.

TEST OF SUCCESS.—The movements should so increase after the first six or eight weeks that within about four months from the operation the patient should be able to move the new joint almost as well as the other, to dress and feed himself, and to lift weights of good size.

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* Pronation and supination in a child are often only apparent, the forearm and arm being rotated together from the shoulder.

† The greater breadth and depth of the trochlear surface on the back than on the front of the humerus must be remembered.

‡ In cases of bony ankylosis, it is best, before attempting to make sections of the bones, either to break down the union forcibly (care being taken not to fracture the possibly atrophied bones above and below), or to divide the bony ankylosis with an osteotome or saw.

§ Mr. Whitehead (*Brit. Med. Journ.*, 1872, vol. ii. p. 534) records the case of an adult in which 2½ inches of the shaft of the humerus had to be removed after sawing off the condyles. Nine months later the patient had full use of the elbow

REPEATED EXCISION.—I have tried this in one instance—a case of obstinate pulpy disease—with entire success. While opening up the old wound and again separating the bone ends gives excellent access to the remaining disease, this step will be but seldom required if the rule is followed, after excision of such joints, to give ether repeatedly as soon as there is evidence of persistent disease, and slit up any sinuses or undermined tissues and thoroughly use sharp spoons. See the remarks made on this subject under "Excision of the Knee." Where the pulpy mischief has burrowed out amongst the muscles, where there is ostitis and osteo-myelitis of the bones, amputation is to be preferred, especially if the general condition of the patient is not satisfactory. In flail-like union, where the limb remains quite useless in spite of the use of a leather support,* where the muscles are not helplessly wasted, and no neuralgia is present, re-excision should be tried in preference to amputation, and a trial may be made of uniting the bones with stout silk or with wire.

Excision in Cases of Gunshot Wounds.—The following points are brought out by Dr. Otis as the results of this operation in the great Civil War of America (*Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 845 *et seq.*). Compared with excision of the shoulder, the results were less brilliant. The cases are divided into the following groups:—I. *Primary Excisions.*—250 cases, with a death-rate of 21.3 per cent. 27 of the 250 were ultimately amputated. II. *Intermediate Excisions, i.e.*, during time of inflammation, three to four weeks.—197 cases, with a death-rate of 35.2 per cent., nearly 14 per cent. greater than that of primary excision. 19 were submitted to amputation later on; 62, or nearly half of the cases, were reported to have complete ankylosis.† III. *Secondary Excisions*, thirty days or more after the injury.—54 cases, with a mortality of 9 per cent.

Period of Election.—Dr. Otis, after remarking that this has hitherto been unsettled, states: "I believe that the evidence, when fully analysed, will demonstrate that this resection conforms to the general rule in shot fractures of the limbs, that primary operations are preferable whenever it is certain that recourse must eventually be had to operative interference." In the future, "intermediate" excision with strict antiseptic precautions and efficient drainage will, probably, be no more dangerous than "primary." The frequency of a flail joint after "primary" excisions is due (α) to the large amount of bone often removed, (β) to the small reparative power of the periosteum uninflamed at this stage, (γ) to the often necessarily inefficient after-treatment. Sir W. Maccormac writes (*Surg. Oper.*, pt. ii. p. 380): "In military surgery most authorities agree that the danger to life is less after a primary resection, but the functional results are not so good, and primary resection is, as a rule, impracticable in the field."

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* See the case mentioned below (p. 67).

† Thus, if patients escape the risks of operations on inflamed soft parts, bones, &c. (p. 56), the ultimate result may be a fixed joint.

Amount of Bone to be removed.—While complete resection * gives more favourable results both as to life and the utility of the limb, Dr. Otis evidently considers it as yet unsettled whether, in cases where the joint is freely opened, but only the humerus or the bones of the forearm are injured, removal of the injured bones alone will not be better.

Of other recent wars, the results of the Dano-Prussian War of 1864 are disputed. The Prussian surgeons have claimed good results after excision of the elbow, owing to (1) the part taken in the care of the wounded by such eminent men as Esmarch, (2) by there being no need to transport the wounded very far. The truth of the above success has been called in question,† owing to the frequency with which flail joints were met with by Danish surgeons amongst Danes operated on by Prussian surgeons.

With regard to the results of this operation in the Franco-German War, Dr. Otis (p. 904) says that the average results met with by the Prussian surgeons are not discouraging, but the results reported by the surgeons attached to the French army of that day are "simply appalling." Dominick has tabulated 263 cases in which the results were accurately noted after the Franco-German War: in 28 cases (10.6 per cent.) there was good active motion, and a more or less useful hand; in 129 cases (49 per cent.) ankylosis took place, in 31 with a useless hand;

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* In some of the above cases removal of detached fragments seems all that was done. This incomplete operation does not appear to be more successful in military than in civil surgery. As pointed out by Prof. Esmarch, free division of the capsule of the joint deprives the wound of much of its danger.

† See a review of a paper by Dr. Hannover (*Brit. Med. Journ.*, January 15, 1870, and *Med. Chir. Rev.*, 1871), and a reply by Dr. Loeffler (*Brit. Med. Journ.*, May 28, 1870).

in 24 cases there was an "active" flail, with a more or less useful hand; in 41 cases a "passive" flail joint, with a useless extremity.

PARTIAL EXCISION.—The value of this has been disputed. My knowledge of it is limited to two cases which came under my observation after removal of the condyles and the olecranon process. A most unsatisfactory amount of stiffness persisted. In cases of disease I should never recommend it, as it is likely to be followed by imperfect removal of the parts affected as well as by ankylosis. So, too, this step should be rejected in cases of ankylosis.* In excision for injury it would be permissible to leave the articular ends of the bones of the forearm untouched when it had been needful to remove the end of the humerus very freely. In such cases early passive movement would be additionally called for.

Dr. P. H. Watson (*Edin. Med. Journ.*, 1873, i. 985) has found that the results after excision for ankylosis are unsatisfactory, either from too great mobility, owing to want of controlling power of the triceps, or from recurrence of bony growth. As in most cases of fracture into the elbow-joint, the humerus is the bone alone affected, and, as removal of the ulna impairs the triceps and brachialis anticus, it is very desirable that neither the radius nor ulna should be interfered with. To meet these points the following operation was devised:—(1) A linear incision over the ulnar nerve, rather longer than that usually employed; (2) the ulnar nerve to be turned over the condyle by careful dissection; (3) a probe-pointed bistoury to be introduced into the joint in front and behind the humerus so as to divide the upper capsular ligaments in front and behind; (4) a pair of bone-forceps to cut off the entire inner condyle and trochlea, and then introduced in the opposite diagonal direction, so as to detach the external condyle and capitellum; (5) the truncated and angular end of the humerus to be cleared, turned out, and smoothed across at a right angle to the shaft with the saw, whereby (6) room might be afforded, so that, partly by twisting, partly by dissection, the external condyle and capitellum are removed without any division of the skin on the outer side of the arm. The union can nearly always be broken down with the aid of an anæsthetic; if not, it can be cut through. Dr. Watson had used this method six times;

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* Sir W. Maccormac points out that in these cases to excise the end of the humerus alone will not permit of pronation or supination afterwards, as the upper end of the radius and ulna are soldered together.

with one exception, a satisfactory result followed immediately after the operation. In this single case osseous union threatened, and the removal of a further slice of the humerus was ultimately satisfactory.

Unfavourable Results of Elbow Excision.

1. Persistence of pulpy disease. This is especially likely when, previous to the operation, the capsule has been perforated and pulpy disease has burrowed out amongst the flexors or extensors (p. 64).

2. Caries and chronic osteo-myelitis. These are not unlikely to supervene when the reparative power is poor and the wound becomes septic.

3. Ankylosis. This is not uncommon in children, owing to the great tendency of inflammatory products to organize quickly in early life. Furthermore, there is the difficulty of getting them to use the joint, or submit to passive movement. All they will do is to move their arm and forearm from the shoulder-joint (p. 62).

4. A flail-like joint.* A limb may remain weak for some time, owing to the muscles not taking on fresh attachments. Friction and galvanism should be used perseveringly. If there is too much separation between the ends, the patient should wear a well-moulded support; the use of the hand and fingers will thus be retained, and, if the patient is young, gradual and great improvement will very likely take place in the elbow. Re-excision and wiring may be tried in some cases with healthy patients. According to Sir W. Maccormac (*loc. supra cit.*, p. 398) most of the flail joints follow the extensive removal of the lower end of the humerus, especially in cases of injury. In such cases the condyles and their muscular attachments should be as little interfered with as possible. He points out that flail joints are of two kinds:—(1) Active flail joints, in which the muscles are strong and exercise control. These may be very useful, especially when aided by a support to the elbow. (2) Passive flail joints, where the muscles are wasted, and the hand only can be used by the employment of a supporting splint.

If the wound becomes septic—

5. Cellulitis, erysipelas, &c.

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* Mr. C. Forster (*Lancet*, 1872, vol. i. p. 3) relates a case in which the right limb was a perfect flail, yet with the help of a leather moulded splint all the movements of fingers were good, and the patient could do needlework, and write well. Such a splint is capped to the shoulder and moulded to the limb down to the wrist, leaving the fingers free, and strapped round the chest.

6. Secondary hæmorrhage. This occurred in 11 out of 250 cases. Otis, *loc. cit.*, p. 860.

7. A useless limb, owing to utterly wasted muscles from long disease and disuse.

8. Injury to ulnar nerve, with its resulting interference with motion, sensation, and nutrition.

9. An adherent scar.

EXCISION OF SUPERIOR RADIO-ULNAR JOINT.

Indications.—This operation may be, very occasionally, made use of, with antiseptic precautions, in old cases of dislocation of the head of the radius, where reduction has not been effected owing to the amount of swelling, &c., and where the movements of the forearm are much hampered, especially in a young and healthy adult.

Operation.—An incision about 2 inches long is made over the projecting head of the bone behind or through the posterior part of the supinator longus.* The soft parts being separated with a blunt dissector and held aside with retractors, the neck of the radius is carefully divided with a fine saw or cutting bone-forceps. Sufficient bone must be removed here or from the external condyle to leave a gap, and avoid risk of fresh ankylosis. The musculo-spiral nerve lies to the inner side, and great care must be taken not to interfere with this or the biceps tendon. The forearm should be put through its movements freely, but carefully, while the patient is under the anæsthetic, so as to break down adhesions. Sufficient drainage must be provided, and every care taken, by not interfering with the soft parts more than is absolutely needful, and by keeping the wound aseptic, to secure primary union, and thus avoid the risk of stiffness again occurring. After a few days a sling may be substituted for a splint, and passive movements made use of daily, with the aid of an anæsthetic if needful.

Mr. Wainwright (*Clin. Soc. Trans.*, vol. xix. p. 332) records a somewhat analogous case, in which, in an adult, he removed the head of the radius, which was vertically fractured, and the coronoid process, which had been imperfectly united with fibrous tissue. The accident had taken place three months before. The movements of the limb were distinctly improved by the operation.

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* The operation will be somewhat easier in the backward dislocation, when the radius rests on the back and outer surface of the external condyle, than in the forward displacement, when the head rests on the front of the humerus in the hollow above the condyle.

UNUNITED FRACTURE OF OLECRANON.

Wiring the fragments of this bone is not often required. For fuller details the reader is referred to the remarks on treatment of ununited patella by wiring.

Indications.—(1) Where, in spite of careful treatment, the limb is weak and its usefulness seriously interfered with, especially where the occupation of the patient requires vigorous extension of the elbow.* (2) Where such treatment has not been used, but the time for it has gone by. In either case the patient should be young and healthy. The object of the operation and its possible risks should be fully explained to him. It is taken for granted that a surgeon undertaking this operation has good reason for feeling confident in his knowledge of antiseptic surgery.

Operation.—The parts being rendered evascular by properly applied Esmarch's bandages, and the region of the elbow-joint duly cleansed,† a longitudinal incision is made for 2½ or 3 inches over the back of the joint, opening into this and exposing the fragments. Any adhesions—*e.g.*, between these and the condyles—are then removed or broken down. Retractors being placed in the wound, any fibrous tissue is separated from the contiguous edges of the fragments, and a thin layer of bone removed from each, either with a chisel or a narrow, sharp saw. A hole is then drilled obliquely through each fragment with a bradawl or drill, and stout ‡ silver wire passed § and twisted up. Two half-twists or one complete twist should be sufficient. If the surgeon decides to leave the wire in, he now cuts the ends short and hammers them down upon the olecranon with a small hammer. If he is going to remove them later on, he leaves the ends, not cut too short, projecting through the wound, which is next closed with silk or wire sutures.

Two questions arise here. One, Should the wire be left or no? I have alluded to this question more fully later on, in the treatment of fractured patella by wiring. While one objection there given is wanting here—viz., the inability to bear pressure on the wire, as in kneeling—two others remain—viz., the fact that, in some patients, attention will be constantly attracted to the presence of the wire, and that, after a time, ulceration may set in around the wire and cause trouble. Thus I believe it to be better in most cases to leave the wire ends fairly long, not short and hammered down, and to remove them in about six or eight weeks' time. The other course no doubt enables the surgeon to allow his patient to return to work after a much shorter interval—viz., three or four weeks—but, as I think, at an undoubted risk.

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* The surgeon will examine how far this power is lost, to what extent the triceps has wasted, and what evidence of union there is between the fragments.

† First by the use of soap and carbolic oil, and then with carbolic acid lotion (1 in 40), a piece of lint soaked in this being worn over the joint for an hour or two before the operation.

‡ Sir J. Lister (*Lancet*, 1883, vol. ii. p. 761) gives wire about $\frac{1}{25}$ of an inch as amply sufficient for the olecranon, while for the shaft of the femur, in an adult male, a piece of wire about $\frac{1}{10}$ of an inch in thickness is requisite in order to resist with certainty the enormous force of the great muscles of the thigh.

§ For difficulties in this, and how to meet them, see "Wiring of the Patella."

The other question is about the drainage. If the parts have not been much interfered with, if no separation of adhesions has been necessary, probably no drainage will be needful, if dry-gauze dressings are applied and firm, and even support given with bandaging. If drainage is considered advisable, a catgut drain will probably be sufficient.

Movement should be begun about the third week, and continued with the persevering and intelligent co-operation of the patient. If the union is firm, the wire may be removed a little later, careful note having been made, at the time of the operation, of the number of half-twists. Occasionally here,* as in the case of the patella, removal of the wire is a matter of some difficulty.

VENÆSECTION.

Indications.

1. Some cases of pneumonia after injury, as where a stout young farmer breaks several ribs when riding, and acute pneumonia sets in and extends rapidly. Here the cyanosis, orthopnœa, the distressing pain, may all be relieved by a bleeding of 8 to 10 ounces, which very likely will have to be repeated.

In other cases of acute pneumonia which are not traumatic, bleeding may be resorted to with great advantage when the patient is young and plethoric, the breathing much oppressed, and the heart's action becoming embarrassed.

2. In some cases of chronic bronchitis. Dr. Hare† draws

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* In a case of Sir J. Lister's (*loc. supra cit.*), the wire was not completely removed from the olecranon, for, the loop having given way near the twist, the twisted part was alone taken away, and the loop left behind, but without causing any inconvenience when the patient was last heard of.

† *Brit. Med. Journ.*, 1883, vol. i. p. 156: "Good Remedies Out of Fashion." Other forms of blood-abstraction, such as leeches and cupping, are spoken of here. The whole address is well worthy of careful study.

this graphic picture of such a case. A middle-aged man with chronic bronchitis and some congestion of the lungs has exposed himself to chill. "He is sitting in a chair (to lie down is impossible for him), his face is blue and sunken, his lips purple, the eyes suffused and staring . . . . his chest heaving, and each short gasping inspiration followed by a long wheezing and moaning expiration ; his lungs are full of moist, sonorous, and mucous rhonchi, scarcely a trace of vesicular murmur is to be heard, and he is pulseless. He looks to you beseechingly, and gasps out, in scarcely articulate words, that he is dying. This is but true. Now, the treatment for such a condition at the present day is to 'pour in stimulants' (though the patient can scarcely swallow). Brandy and water are given, and ammonia, and perhaps ether ; then, if the patient lives long enough, mustard poultices are applied to the chest and the calves and feet, and the patient is fanned, and the patient dies. . . . . Appearances have been saved, but not the patient's life. The fact is that here the danger lay in the right side of the heart being gorged with blood, so that it was impossible for its stretched and distended walls to contract and to propel forwards the thick and blackened blood. . . . . Open one of these veins, which are, with every systole of the heart, tending to carry more and more blood to this already distended right ventricle, and all may yet be well with your patient."

3. Where a tendency to apoplectic seizures exists.* Dr. Hare (*loc. supra cit.*) thus writes of this class of case. Nature speaks "in unmistakable language when by a copious epistaxis she efficiently relieves the congested turgid face,† the beating temples, the dull heavy headache, the sleepiness, the confusion of thought, and other symptoms, which, in a plethoric individual betoken, if they are not relieved, serious danger, if not an apoplectic attack."

4. In aneurisms, especially thoracic. As part of the treatment of Valsalva in a modified form. Formerly the bleedings in aneurism were copious even to syncope. Nowadays they are made use of differently. They are small in amount, and are only repeated so far as to reduce excessive action of the heart, or to relieve certain symptoms (as they undoubtedly do)—viz., dyspnœa and pain. Dr. MacDougall, of Carlisle, in a most interesting paper

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* This does not mean those cases where a rupture of a cerebral vessel has occurred, where bleeding would interfere with that process of repair on which the patient's life depends.

† Dr. Copeman (*Brit. Med. Journ.*, 1879, vol. ii. p. 932) points out that in these cases, in addition to plethora and a full habit, evident distension of the superficial veins of the head and neck is a valuable indication that bleeding is proper.

(*Amer. Journ. Med. Sci.*, 1887, p. 38) points out the following as cases in which venæsection should be used more often when other means have failed. (1) Details are given of a case of mitral and aortic incompetence, with chronic Bright's disease, and acute pleuro-pneumonia, in which recovery followed epistaxis to the amount of a pint. (2) Reaction after concussion, with a full, slow, labouring pulse, and headache. (3) In epilepsy in strong, big, healthy patients, venæsection will relieve the cerebral stasis. (4) In some cases of croup, in late childhood, or in vigorous adolescents. (5) In acute pleurisy, with intolerable pain, unrelieved by morphia; where there is not much effusion, but lymph formation over a wide surface. (6) Very rarely in acute pneumonia, bilateral, in young healthy subjects, with small pulse and strongly beating heart. It is pointed out that the pyrexia here favours the dilatation of the right side of the heart. (7) In suffocative pulmonary catarrh, with a trace of albumen and a few granular casts. (8) In some cases of convulsions, *e.g.*, (*a*) after scarlatinal nephritis; (*b*) in parturient or pregnant women—*i.e.*, in severe attacks, with extreme congestion, profound coma, and hard pulse; (*c*) in plethoric coma, preceded by headache, in full-blooded women about the time of the menopause.

Operation.—The patient being usually in a sitting position, and a bandage tied round the middle of the arm with sufficient tightness to retard the venous circulation without arresting that in the arteries,* the surgeon selects the median cephalic or the median basilic, whichever is most prominent.† Steadying this vein by placing his left thumb upon it just below the point of intended puncture, and with his right hand resting steadily upon its ulnar margin, he opens the vein with a scrupulously clean lancet or small sharp scalpel, making with a gentle sweep of his wrist a small incision, and not a mere puncture, into the vein. The anterior wall of this being divided, the point, without penetrating any deeper, is thrust onwards, first increasing the slit in the vein, and then being brought out vertically, care being taken to make the skin wound larger than that in the vein. The thumb is now raised and the stream directed into the measure.‡ While the blood is escaping, the limb should be kept in the same position, lest, by the skin slipping over the wound in the vein, the blood should be prevented from escaping freely and make its way into the cellular tissue.

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* The surgeon makes use of the pulsation in the arteries to tell the relation of the brachial, or one of its branches given off abnormally high up and running superficially, to the veins at the bend of the elbow (p. 85).

† If the patient is nervous, or if the veins are small, he should be told to hold a walking-stick or book. This steadies his arm, distracts his thoughts, and by producing muscular contraction supports and fills the veins.

‡ Not a drop of blood should be allowed to go on to the bed or patient's linen.

The required amount of blood having been removed, the thumb is placed on the puncture while the bandage is removed. A small pad of lint dusted with iodoform or of dry aseptic gauze is then placed on the puncture, and secured with tape or bandage applied in the figure of 8. This pad may be removed in about forty-eight hours, and for a day or two the patient should use a sling.

Difficulties during, and Complications after, Venæsection.

1. Difficulty in finding a vein. This may be due to their small size, the feebleness of the circulation, or the abundance of fat. If a vein cannot be made sufficiently distinct by hanging down the limb, putting it in warm water, flexing and extending the wrist and fingers, and chafing the limb, a vein should be opened on the back of the hand, or blood withdrawn from the external jugular or internal saphena at the ankle.

2. In other cases, where the patient is much emaciated, owing to the absence of steadying fat the mobility of a vein may enable it to avoid puncture, unless a very sharp instrument is used and the vein well steadied.

3. When the vein has been opened, sufficient blood may not escape owing to—

(*a*) The opening being a mere puncture.

(*b*) The skin-opening being insufficient in size, or not parallel in position to that in the vein. These impediments are removed by a freer use of the knife, carefully made, or by bringing the wound in the vein parallel with that in the skin.

(*c*) A pellet of fat may block the opening in the vein. This should be snipped away.

(*d*) The patient may faint.

(*e*) A thrombus may form. This will disappear when the venous current becomes more active.

(*f*) The bandage may be tied too tightly round the arm.

4. Wound of the brachial or some other artery—*e.g.*, an abnormal ulnar. This can always be avoided by a careful use of the lancet or scalpel, and by noting beforehand the existence of any pulsation. The force of the jet and the mixture of bright with dark blood will tell of this accident. Pressure should be carefully applied and maintained (p. 19), and blood taken from the opposite arm if required.

5. Escape of blood into the cellular tissue. This will lead to ecchymosis, and perhaps formation of a thrombus, which may be absorbed, but which also may suppurate.

6. Phlebitis, or inflammation of the lymphatics. These may be due to use of dirty instruments, aided by the low condition of the patient. They should be most carefully guarded against, as likely to lead to the following two most grave results.

7. Erysipelas and cellulitis.

8. Intense pain in the limb, with gradual flexion of the elbow-joint. This is due to puncture of the external or internal cutaneous nerves, which are connected through the brachial plexus with the motor nerves to the brachialis anticus and biceps, which flex the elbow-joint.* The injured nerve should be divided, subcutaneously if possible.

TRANSFUSION.

This operation is rarely performed—(1) from the fact that it is apparently very fatal, though the bad results are, as in tracheotomy for croup or in herniotomy in cases of strangulation, not due so much to the operation itself, as to the condition which calls for it. (2) From the difficulties attending the operation. These, of late years, have been much diminished, but, while we have simpler apparatus at hand, it is probably still correct that there is none which has been used sufficiently often to be called perfect. Yet it is an operation with which every practitioner should be acquainted, owing to the critical nature of the cases in which he is called upon to perform it, and the suddenness with which the call is liable to come.

There are two methods—A. Direct, in which blood is conveyed directly from one person into another; and B. Indirect, in which blood separated from its fibrin, or some other fluid is thrown in.

A. **Direct.**—This will be described first and most fully, as it is probably preferable to inject blood without exposure to air and without manipulation in the cases in which this method is available.

Method.—DR. AVELING'S MODIFIED BY MR. CRIPPS.—As I have only space for one here, I shall describe that with which I am most familiar. It is simple and inexpensive,† and has the advantage of measuring the blood sent—viz., 2 drachms at each squeeze of the bulb.

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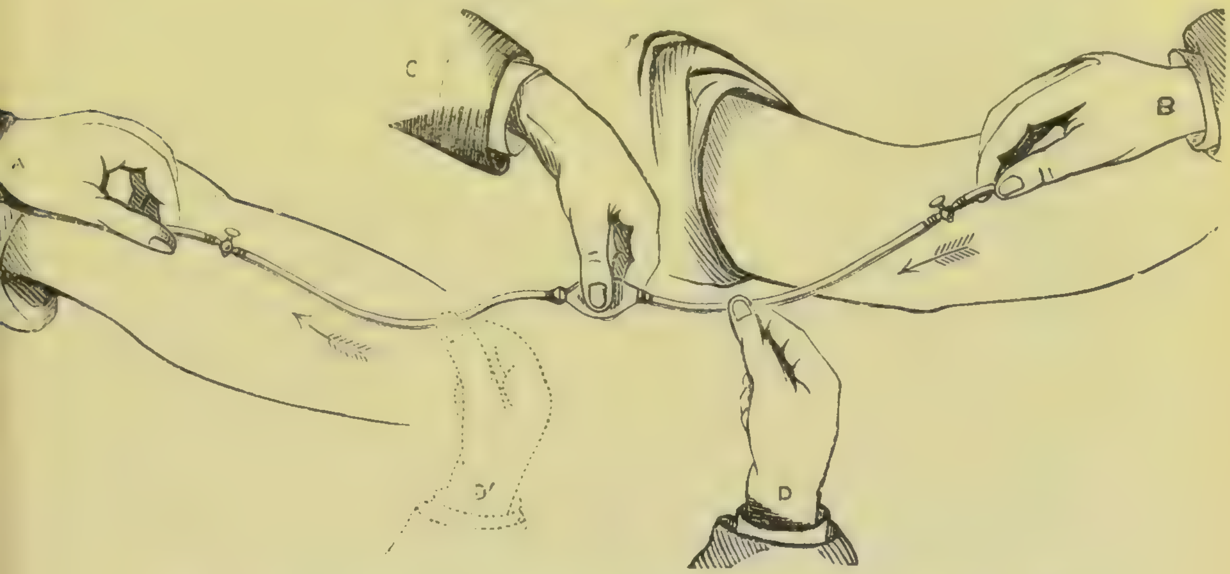
* Hilton, *Rest and Pain*, p. 190.

† I may remind my readers that, as in the case of all india-rubber instruments, this, unless kept carefully and looked at from time to time, is liable to be found cracked and useless at the moment of need. I believe the only means of really

The veins being exposed and probes passed beneath them, the apparatus is filled with a warm solution of sodium chloride, and a clip placed at either end. The arms of receiver and donor being in the position given below, the vein of the receiver is opened with sharp scissors, and pressure being made just below the opening in the vein, so as to prevent blood obscuring the opening, the cannula is inserted. The other cannula is then inserted into a vein of the giver, and both held steadily by an assistant. Transfusion is then performed as follows :†—

FIG. 26.



A and B are the hands of assistants holding the afferent and efferent tubes and the lips of each venæsection wound together. The cannulæ being inserted into the veins, the syringe and tubing, filled with warm saline solution, and kept so by the taps or clips, is fitted into the cannulæ. Then the taps are turned or the clips removed, and the tubing compressed by D, and the bulb squeezed by C. The tube is then squeezed by shifting D to D′. The bulb then expanding draws in blood, when the manipulation just described is repeated. The bevelled end of the afferent tube is so made that it may slip easily into the collapsed vein of the patient. (Aveling.*)

“ The clips having been removed from the tube at either end, the operator makes the necessary valve to prevent regurgitation by compressing, with the finger and thumb of one hand, the tube between the central ball and the giver. He then slowly squeezes the ball, with the effect of driving the water it contains gently into the vein of the recipient ; then, having compressed the tube

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ensuring the preservation of india-rubber is to keep it under water. Mr. Cripps has removed one source of clotting by replacing with clips the taps shown in Fig. 26.

[*] *Obst. Trans.*, vol. vi. May 4 1874.

[†] Cripps, *Dict. of Surg.*, vol. ii. p. 660.

between the ball and the recipient, he removes the finger and thumb from off the tube on the opposite side, allowing the ball to expand with the blood coming into it from the arm of the giver. When the ball is full, the manipulation just described is repeated, and the blood passes into the vein of the receiver. In this manner, each time the ball is compressed 2 drachms of blood are injected into the veins of the patient. Should the syringe appear to become blocked,* or work unsatisfactorily, it can be detached and washed out without removing the cannulæ from the veins."†

B. **Indirect Transfusion.**—Points which have here to be considered are—(1) What is the best fluid to use. (2) What is the best apparatus and method.

Milk‡ has been used by some—*e.g.*, Dr. Thomas, of New York—being thought to be safer and more nutritious than saline fluids. Possibly this last advantage is somewhat theoretical, being based on the supposed resemblance to chyle. If milk be injected, it should be first most carefully filtered to prevent any capillary embolism in the lungs.

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* A case in which this occurred will be found related by Dr. Hoggan, *Brit. Med. Journ.*, 1877, vol. ii. p. 726.

† I can only mention some other methods. Dr. Galabin's (*Guy's Hosp. Repts.*, vol. xlii. p. 255) is in some respects simpler than the one described. The apparatus is more easily cleaned and is less liable to get out of order. It is well suited to direct and indirect transfusion alike, but during the former it has the disadvantage that the quantity of blood cannot be easily and exactly measured. The surgeon can only judge when to leave off by the time of the flow, which should not be less than five minutes, and partly by the effect on the pulses of receiver and donor. M. Roussell's instrument appears to me to have the following grave objections:—(1) Its cost (£5 5*s.*; Dr. Aveling's, £1 12*s.*), which is very high for one so rarely used. (2) Its complicated nature. (3) The fact that its safety depends on its being used rapidly. As Dr. Galabin remarks, "A general practitioner, having occasion to operate but once in a lifetime, might occupy more time, and the risk to the patient is thus immensely increased." (4) Although the first few ounces of blood pass quite successfully, yet, after a while, clots usually form in the tube. Mr. Cripps (*loc. supra cit.*) further condemns it as most unsurgical, and as "merely an attempt to substitute the haphazard, blind puncture of a machine for the human fingers and eyesight, which alone are to be relied on in performing so delicate an operation as transfusion, with ease, safety, and precision." It is, however, only fair to the inventor to state that in the *Yearbook of Treatment* for 1886, p. 90, M. Roussell is stated to have performed transfusion by his method successfully eighteen times in thirty-nine surgical cases; and in medical cases twenty-eight times, with ten recoveries. No information is, however, given in the book just quoted as to the severity of the cases, or the condition of the patients.

‡ Prof. Schäfer (*Trans. Obst. Soc.*, vol. xxi.), from experiments on dogs, found that the injection of milk, after they had been reduced by bleeding to almost a lifeless condition, caused a temporary rise in the blood pressure, but no permanent benefit. After death, the blood corpuscles were found to be disintegrated, and the blood swarming with bacteria. He was strongly of opinion that no fluid lacking hæmoglobin could be of any benefit in cases of acute anæmia.

Saline solutions have also been used, being always available in the absence of a fitting blood donor, and in the hope that thus sufficient fluid would be supplied to stimulate the failing action of the heart, and to give it something to contract upon until the processes of assimilation, which are in these cases suspended, can once again supply natural fluid to the heart and vessels. The transfusion of saline solutions received at one time some impetus from a certain amount of success which attended their use in cholera. Thus Mr. Little (*Lond. Hosp. Repts.*, vol. iii. p. 132) reports four recoveries out of fifteen cases so treated at the London Hospital. The fluid used consisted of a drachm of sodium chloride, 6 grains of potassium chloride, 3 grains of sodium phosphate, 20 grains of sodium carbonate, and 2 drachms of pure alcohol to a pint of distilled water.* Four pints were introduced at a time, at a temperature of about 110°, the transfusion taking about half an hour.

If blood is available, it may be used as follows:—Six ounces are drawn from the arm of a strong and healthy man into a scrupulously clean receiver. The fibrin having been whipped up by brisk use of a clean silver fork, the blood is strained through muslin (previously dipped in hot water) into a vessel floating in water at 105°. A vein is now found in the patient's arm, a matter, sometimes, of no small difficulty. A probe is passed beneath the vein to prevent its being lost later on, and tapes are tied around the arm just above and below the spot where it is to be opened. The vein being opened with sharp scissors, a small probe is inserted, so that the aperture is readily found. The prepared blood is now placed handy, and the apparatus chosen, whether a glass syringe which has been kept filled with hot water, with a piece of tubing attached, ¼ inch in diameter and about

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* The fluid recommended by Mr. Jennings is somewhat similar—viz., sodium chloride, grs. 50; potassium chloride, grs. 3; sodium sulphate, grs. 2.5; potassium sulphate, grs. 2.5; sodium phosphate, grs. 2; water, 1 pint; absolute alcohol, drs. 2. It seems probable that the use of saline injections will receive further trial. Dr. W. Hunter has lately (*Brit. Med. Journ.*, July 27, Aug. 3 and 10, 1889) dealt fully with the subject of transfusion. In discussing the relative value of blood and saline solutions, he shows that blood must have a stronger effect in restoring the tone of the vaso-motor centres, and that if anything like all the volume of blood is lost, blood must take its place. The advantages of salines are otherwise very great, being easily obtained and free from such dangers as clotting. He thinks that for practical purposes all the advantages of transfusion can be equally well and as rapidly obtained by transfusion of a 3 to 4 per cent. solution of salt (ʒj—Oj).

3 inches long, with cannula,* metal or glass, or a piece of the same sized tubing, 3 feet long, with a funnel at one end and appropriate cannula at the other—whatever apparatus, and the simpler the better, is used is carefully filled with blood. The probe being withdrawn from the vein, the cannula inserted, and the tapes removed, blood is introduced very slowly, and the effect on the patient's pulse, breathing, temperature, and face carefully watched. The average amount required is from 4 to 6 ounces. If needful, the flow may be accelerated by running the oiled finger and thumb down the tube. But if the flow seems arrested or nearly arrested, it is better to withdraw the cannula for a moment and make sure that there is not a clot in the cannula or tube.

It has been suggested that some saline solutions which have the power of delaying the coagulation of blood—*e.g.*, sodium phosphate —should be added to the blood before it is transfused. Dr. Hicks (*Guy's Hosp. Repts.*, vol. xiv. p. 1) brought this method before the profession, having found experimentally on dogs that blood mixed with sodium phosphate, after being kept out of the system for some time, could be injected back into the animal without any detriment. He therefore hoped that this plan might be useful where there is no time for defibrinating, or where the quantity of blood obtainable is so small as to render defibrination difficult. Dr. Hicks recommends a solution of 3 ounces of the fresh sodium phosphate dissolved in a pint of water, using one part of the solution to three parts of blood, and injecting from 6 to 8 ounces of the combined fluid, this being done very slowly and at intervals if the heart's action is embarrassed by the use of more than 2 ounces at a time. Prof. Schäfer,† who investigated the subject of transfusion scientifically for the Obstetrical Society, considered that this solution was too strong, and certain to kill the blood corpuscles.

There is one more method of transfusion, or rather of re-infusion, which has been used lately by the Edinburgh surgeons—viz., Dr. Duncan‡ and Messrs. Annandale and Cotterill §—and which, being especially adapted to amputation cases, is of great interest to the hospital surgeon. Dr. Duncan used it successfully in a case of amputation of the thigh for a railway injury. The patient, who had lost so much blood before the operation that it was difficult to say whether he was alive or dead after the arteries were tied, made a good recovery after the injection of the 3 ounces of blood which he had lost during the operation mixed with solution of sodium phosphate—in all, about 8 ounces being thrown into the femoral vein.

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* The end of this must always be fine enough to enter the vein, which is usually collapsed.

† *Obst. Trans.*, vol. xxi.

‡ *Brit. Med. Journ.*, 1886, vol. i. p. 192.

§ *Ibid.*, vol. ii. October 2.

Dr. Duncan's method is as follows :—

For introduction into the vein, a short glass tube, of the size of a No. 6 catheter, having a pen-shaped point, is used. To its other end, slightly bulbous, about 2 inches of india-rubber tubing are attached. A simple glass syringe, holding 4 ounces, whose nozzle fits the tubing, is perfectly effective, the temperature being kept up with boric lint wrung out of hot water. A graduated glass vessel, kept floating in warm water, contains the solution of sodium phosphate and receives the blood.

All instruments are washed in aseptic solutions. The most convenient vein being selected on the face of the stump, the glass point is inserted and a catgut ligature put round it. While the process of ligaturing the arteries is going on, the blood is caught by one assistant, who adds the soda solution as required, and is slowly injected by another.

The solution of sodium phosphate was one of 5 per cent., one part of the solution being added to three parts of blood. A slightly larger proportion was frequently used in the amputation cases.

About five minutes were occupied in injecting the 8 ounces, and, in a case of amputation of the hip, 16 ounces were injected in about fifteen minutes, without any disturbance, and with a good result.

Dr. Duncan points out that the process of re-injecting the patient's own blood is incompatible with the use of spray or irrigation during the operation. In most cases, however, the use of the germicide may safely be delayed till near the end of the operation, as, with pure hands and instruments, the risk from the air is trifling, and is not worth considering when a patient is in imminent danger from hæmorrhage or collapse.

The same apparatus was thus used in a case of pernicious anæmia by Dr. Duncan :—

A vein in the arm of the receiver was exposed, and under it a double thread of catgut passed. Blood was then drawn from the donor into a dish containing the sodium phosphate, with which it was gently mixed by means of a glass rod. While an assistant fitted the syringe, the exposed vein of the receiver was opened, and the lower thread of catgut was gently pulled upon to prevent bleeding. The tube was now inserted, the upper thread tied round it with one knot, and the lower definitely secured and cut short. The blood was next slowly injected, the tubing being pinched when the syringe required to be refilled. The upper catgut was finally tied and cut short when the operation was completed, and the little wound was stitched up.

Arterial Transfusion.—While transfusion into veins is in practice, on the whole, the most generally convenient and applicable method, the above is, theoretically, so superior that it deserves attention. Prof. Schäfer (*loc. supra cit.*) recommends the following method to be used in the dorsalis pedis artery :—

The arteries of donor and receiver are first to be exposed and separated from their sheath for about $\frac{3}{4}$ inch. The distal ends of the exposed portions of arteries in both are then tied, ligatures are placed loosely round the upper ends also, and these upper ends secured by spring clips. The transfusion apparatus itself consists simply of an india-rubber tube having a glass cannula at each end. The cannula has a tapering, bevelled end, grooved to hold the ligature. One of the cannulæ is tied into the artery of the donor, the other into that of the receiver, the ends of both being directed towards the heart. The clips are then opened for about a minute, or a little longer if it seem desirable. Both arteries are then to be tied just above the clips, and finally the cannulæ are to be cut out, together with the pieces of artery into which they are tied.

ADVANTAGES OF ARTERIAL TRANSFUSION.

1. The blood transfused is oxygenated.

2. Any clots produced are washed into the peripheral arteries of the foot, instead of into those of the lungs.

3. The arterial tension of the patient is more quickly raised, and the tendency to syncope thus more rapidly averted, than when the blood is thrown into a vein.

DISADVANTAGES OF ARTERIAL TRANSFUSION.

1. An artery is more difficult to find and deal with, especially in cases of hurry and emergency, than a superficial vein.

2. Emboli, if produced, and carried into the peripheral arteries, may produce gangrene of the part.

3. It is a more serious operation for the donor at the time, and requires him to be more careful later on.

4. An artery thus used is only available once.

Risks and Dangers of Transfusion.—Amongst these are :—

1. Emboli and their results.

2. Evidence of blood being thrown in too rapidly for the

system of the receiver—*e.g.*, headache, flushing, præcordial oppression, &c.

3. Perhaps septic absorption, if the blood has been exposed too long, or if milk is used without precautions to purify it.

4. Many of the risks already given under the head of venæsection (p. 74) will, of course, be present here also.

LIGATURE OF THE BRACHIAL ARTERY AT THE BEND OF THE ELBOW (Fig. 17).

This operation, common enough fifty years ago owing to the frequency of bleeding and the facility with which the brachial artery was wounded, will be briefly described here.

Indications.—(1) Wound of artery, especially after bleeding. (2) Traumatic arterio-venous aneurism also occurring after bleeding.

GUIDE.—The inner side of the biceps tendon.

RELATIONS :—

IN FRONT.

Skin ; fasciæ ; bicipital fascia ; median basilic vein. Branches of internal and external cutaneous nerve.

OUTSIDE.		INSIDE.
Biceps tendon. Vena comes.	Brachial artery at bend of elbow.	Median nerve. Vena comes.

BEHIND.

Brachialis anticus.

Operation (Fig. 17).—The limb being steadied with the elbow slightly flexed, the site of the biceps tendon should be defined, and also that of any large veins, by making pressure a little above the proposed site of ligature. An incision about 2 inches long is then made, a little to the inner side of the biceps tendon, through the superficial fascia carefully, so as to avoid the median basilic vein and its companion, the internal cutaneous nerve. If these are seen, they must be drawn inwards. The deep fascia is then divided on a director, this and the semilunar fascia of the biceps which strengthens it being interfered with as little as possible. The artery, with its venæ comites, lies directly underneath. The needle should be passed, after the veins are separated and the artery cleaned, from within outwards, so as to avoid the median nerve, which lies more deeply on the inside.*

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* If it is needful to prolong the incision downwards so as to secure the upper end

In the case of traumatic arterio-venous aneurism resisting other treatment, the old operation of placing double ligatures * will be preferable to the Hunterian one, which runs the risk of overlooking the possibility of a rather higher division than usual of the brachial into radial and ulnar. If much hæmorrhage is expected, the brachial should be compressed about the middle of the arm with an Esmarch, or the vessel controlled by a reliable assistant. The median basilic vein will, in such cases, be often found much dilated by the entrance of arterial blood. In others it has been obliterated.

This operation at the bend of the elbow should always be performed with the utmost carefulness at the time, and pains taken with the after-treatment, so as to insure the minimum of disturbance and the smallest amount of cicatrix, and thus to interfere as little as possible with the movements of the elbow.

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of the radial or ulnar, the bicipital fascia must be divided more freely, and the median basilic vein cut if it cannot be drawn to one side.

* Here ligatures will be required above and below the communication with the vein in the case of aneurismal varix, and above and below the sac if the surgeon is dealing with a varicose aneurism, it being understood that palliative treatment has not sufficed, and that pressure, applied locally and on the main trunk above, or by means of Esmarch's bandage, has failed. If ligature is decided upon, it will be better (the artery being commanded above) to open the sac, and thus find the apertures into the artery by the aid of a small bougie. As Mr. Holmes (*System of Surgery*, vol. iii. p. 92) points out, the other plan of attempting to find and tie the artery without opening the sac presents these difficulties—viz., that the artery is surrounded by dilated and closely packed veins, and that below the sac it is of small size.

CHAPTER V.

OPERATIONS ON THE ARM.

LIGATURE OF BRACHIAL ARTERY (Figs. 27, 33).

This is performed (*a*) in the middle of the arm, and, much more rarely, (*b*) at the bend of the elbow, the operation last described.

(*a*) In the Middle of the Arm (Figs. 27, 33).

Indications.

1. Chiefly wounds of palmar arch, resisting pressure (p. 23).
2. Wound of the artery itself by penknife,* bayonet, bullet, &c.
3. Gunshot wound of the elbow, leading to secondary hæmorrhage, resisting other treatment.
4. Wound of one of the arteries of the forearm, when hæmorrhage has occurred from a wound of one of these and the parts are in a sloughy condition. In the year 1882 a patient came under my care for secondary hæmorrhage from a wound of the forearm, inflicted by the bursting of a gun in rook-shooting. The parts were much swollen and sloughy; the ulnar artery in its middle third, from which the hæmorrhage was coming, was greenish in colour, and apparently not in a condition to hold a ligature. A good recovery, with no further hæmorrhage, took place after ligature of the brachial in the middle of the arm. In 1885 I had occasion again to tie this artery for hæmorrhage occurring repeatedly a few days after a suppurating palmar bursa had been opened in the usual way, above and below the anterior annular ligament. The patient recovered with a weakened limb.
5. Traumatic aneurism.
6. Spontaneous aneurism. As is well known, spontaneous

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* Mr. Sheild (*Lancet*, 1887, vol. i. p. 978) has recorded a case of stab wound of the brachial with many points of interest. A penknife wound had reached the artery by passing from without inwards through the biceps. The bleeding was arrested by pressure. The wound healed, and twenty days later a fall caused the cicatrix to give way, profuse hæmorrhage following. Esmarch's bandage being applied, a free incision was made, and the bleeding point found by searching with a bent probe, the end of which passed into an opening in the brachial artery. Ligatures were applied above and below. Owing to the swelling of the arm no sutures were used. A good recovery took place.

aneurisms are very rare in the upper extremity, and usually associated with cardiac disease. Treatment here should not be too active ; ligature should only be thought of where the aneurism is rapidly increasing, or causing painful pressure upon a nerve. Traumatic aneurism is decidedly under the influence of pressure. If this fails, it is a question if the old operation is not superior to the Hunterian, for the sac is often imperfect.*

Dr. Holt (*Amer. Journ. Med. Sci.*, April 1882) only succeeded in collecting thirteen cases of spontaneous aneurism of the brachial artery. From his paper he concludes that pressure should always be tried first. This is more likely to be successful in aneurisms low down in the brachial artery than in those in its upper third, as pressure is more easily applied in the former case, owing to the less close relation of nerves to the artery. It is probable that antiseptic precautions will enable the surgeon to deal successfully with spontaneous aneurism in the upper extremity, even when associated with cardiac disease.

LINE.—From the junction of the middle and anterior thirds of the axilla, along the inner edge of coraco-brachialis and biceps, to the middle of the elbow triangle. This line is of especial importance when, owing to swelling, &c., the edge of the biceps is difficult to make out.

GUIDE.—The above line and the inner edge of biceps.

RELATIONS in arm :— IN FRONT.

Skin ; fasciæ ; branches of internal and external cutaneous nerves.

Median nerve† (about centre of arm).

OUTSIDE.		INSIDE.
Coraco-brachialis (above).		Ulnar nerve.
Biceps.	Brachial artery in arm.	Internal cutaneous nerve.
Vena comes.		Vena comes.
		Basilic vein, superficial to deep fascia in lower half, beneath it above, usually.

BEHIND.

Triceps (middle and inner heads) ; coraco-brachialis ; brachialis anticus.

Musculo-spiral nerve and superior profunda artery (above).

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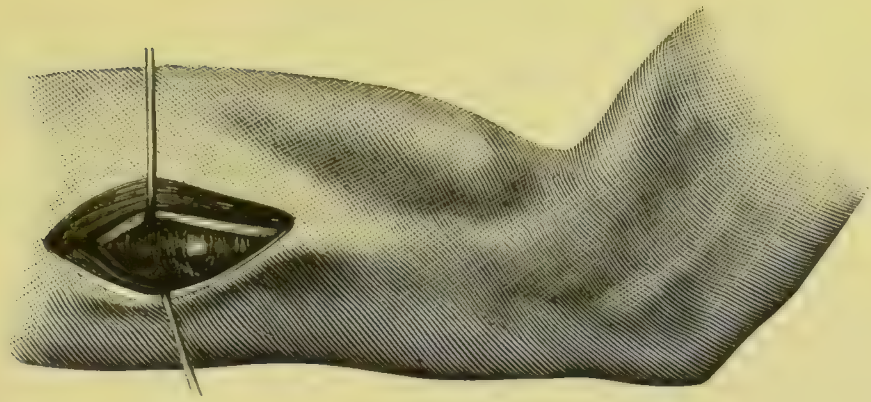
* Holmes, Roy. Coll. Surg. Lect., *Lancet*, October 25, 1873.

† In one out of every six cases the median nerve lies under the artery : Skey, *loc. supra cit.*, p. 269.

FIG. 27.



Collateral Circulation.

(*a*) If the ligature be placed above the superior profunda, the vessels chiefly concerned will be—

Above.		Below.
The subscapular The circumflex	with	The superior profunda.

(*b*) If the ligature be placed below the superior profunda—

Above.		Below.
The superior profunda	with	The radial recurrent. The posterior ulnar recurrent. The interosseous recurrent. The anastomotica magna.

(*c*) If the ligature be placed below the inferior profunda—

Above.		Below.
The superior profunda The inferior profunda	with	The radial recurrent. The ulnar recurrents. The interosseous recurrent. The anastomotica magna.

Abnormalities.—These are so far from infrequent* that the surgeon must be prepared for the following :—

1. The artery being in front of the nerve (foot-note, p. 84).

2. A high division of the artery. According to Mr. Quain, in one out of every five cases there were two arteries instead of one in some part, or in the whole, of the arm. The point of bifurcation is thus described by Gray : " It is most frequent in the upper part, less so in the lower part, and least so in the middle, the most usual point for the application of a ligature ; under any of these circumstances, two large arteries would be found in the

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* Numerous instances of these are figured by Mr. Reeves in the Appendix to hi *Human Morphology*, vol. i. p. 692 *et seq.*

arm instead of one. The most frequent (in three out of four) of these peculiarities is the high origin of the radial. That artery often arises from the inner side of the brachial, and runs parallel with the main trunk to the elbow, where it crosses it, lying beneath the fascia; or it may perforate the fascia, and pass over the artery immediately beneath the integument."*

3. The artery may be partially covered by a muscular slip given off from the pectoralis major, biceps, coraco-brachialis, or brachialis anticus.

4. One or more slender vasa aberrantia may be met with in the arm, passing from the axillary or the brachial to one of the arteries in the forearm.

Operation (Figs. 27, 33).—The arm being extended and abducted from the side, with the elbow-joint flexed and supported† by an assistant, the surgeon, sitting between the limb and the trunk,‡ makes, beginning from below or above as is most convenient, an incision 2½ inches in length along the inner border of the biceps, going through the skin and fasciæ, and exposing just the innermost fibres of this muscle.§ This is then drawn outwards with a retractor, the median nerve next found and drawn inwards or outwards with a strabismus hook, and the artery defined and sufficiently cleared, when the ligature is passed from the nerve. In doing this the basilic vein and the venæ comites, which increase in size as they ascend, must be carefully avoided.

I would point out that the brachial artery is by no means so easy a vessel to tie as might be supposed from its superficial position. This is especially the case when the artery is concealed by the median nerve at the point where it is sought, and when its beat is feeble and the vessel itself small and but little distended after repeated hæmorrhage lower down.‖

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* The possibility of this superficial position of the radial or ulnar should always be remembered when venæsection, or ligature of the brachial, at the elbow is about to be performed. See also the foot-note, p. 72.

† Mr. Heath has pointed out (*Operative Surgery*, p. 18) that if the arm when at a right angle to the body be allowed to rest upon the table, the triceps is pushed up, and displacing the parts may bring into view the inferior profunda and the ulnar nerve instead of the brachial and the median nerve.

‡ This is, to my mind, a much more comfortable position than standing on the outer side and looking over.

§ Authorities differ as to this step. I strongly advise the operator to avail himself of this guide. If it be done carefully, and the wound kept sweet afterwards, it can do no harm. The fibres of the muscle are a distinct help, and (as stated above) ligature of this artery is not as easy a one as it would appear.

‖ This was so marked in the second of the two cases mentioned at p. 83 that,

AMPUTATION OF ARM (Figs. 29, 30, and 31).

Indications.—Amongst these are:

1. Accidents, *e.g.*, compound fractures, machinery accidents, &c., which do not admit of any part of the forearm being saved, or of amputation of the elbow.

The advisability of amputation in these cases is discussed, once for all, in the chapter on the antiseptic treatment of compound fractures.

2. New growths involving the forearm, and not admitting of extirpation.

3. Disease of the elbow-joint not admitting of excision, or in which this operation has failed (p. 57).

4. Gunshot injuries of the upper part of the forearm, elbow, and arm not admitting of conservative treatment or excision.

So inestimable is the value, even when only partial, of the hand, and so good are the results of conservative treatment and secondary amputation, that the tissues must be almost disorganized for the surgeon to think of primary amputation here.*

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on my exposing the vessel, several bystanders felt certain that it was not the brachial, but one of its branches.

* Dr. Otis (*loc. supra cit.*, p. 916) thus sums up on the question of conservative surgery, excision, and amputation in gunshot injuries of the elbow-joint :—"The practical conclusions that appear to be deducible from the foregoing investigations are—(1) That in shot wounds in young healthy subjects attended with slight injury of the articular extremities of the bones of the elbow, such as fractures of the olecranon, of the outer condyle, or of the trochlea, without much splintering and without lesion of the important vessels and nerves, it is justifiable in many instances to attempt an expectant conservative treatment, keeping the injured extremity in entire rest, after removing any detached fragments or foreign bodies, in a semi-prone and very flexed position, employing ice or other cold applications. If the inflammatory action becomes intense, the wounds should be freely enlarged, and the joint-cavity freely laid open, and easy escape provided for the altered wound secretions by position and drainage-tubes. The strength should be sustained by a tonic regimen, and when the inflammatory stage has completely abated, and not before, if healing is slow, secondary excision or amputation may be hopefully resorted to. Unless all the favourable conditions mentioned are present at the outset, it would be safer to resort to primary excision or to amputation. (2) In grape-shot comminutions with lesions of the principal vessels or nerves, amputation should be practised immediately after the reception of the injury. (3) In severe shot fracture, without extensive lesion of the soft parts, the joint should be freely exposed by a longitudinal posterior incision, and the full extent of the fracture ascertained. Unless there is extraordinary fissuring, the injured joint-ends should then be sawn off as close to the limits of injury as possible, save that the bones of the forearm should be shortened to the same level. If the splintering extends very far, or if there is reason to believe that the humeral vessels are injured though not wounded, the incision should be so modified as to convert the operation into an amputation."

Amongst the special conditions which will have to be considered are the size of the projectile, the gravity of the laceration of the soft parts, the amount of longitudinal splintering of the bones, the extent of lesions to the vessels and nerves, and the degree to which suitable conservative measures can be adopted in the absence of hospital facilities or of easy transportation.*

If the surroundings of the surgeon and patient admit of it, attempts will nowadays be made to suture the nerve ends, especially when only one or two of the chief trunks are involved. Whether the old doctrine, that shot-fracture of the humerus with wound of the brachial artery imperatively indicates amputation, is correct must remain uncertain. Dr. Otis (*loc. supra cit.*, p. 674) writes on this point: "I confess that the evidence in the reported cases appears to me insufficiently circumstantial and precise to decide affirmatively this controverted point."

Methods.

i. Skin flaps with circular division of muscles—(*a*) antero-posterior flaps, (*b*) lateral flaps.

ii. Transfixion flaps, usually antero-posterior.

iii. Skin and transfixion flaps combined.

iv. Circular. v. Single flap. vi. Teale's method.

i. **Skin Flaps with Circular Division of Muscles.**—This should be made use of in bulky muscular arms.

(*a*) ANTERO-POSTERIOR FLAPS.—The brachial having been controlled,† the limb supported at a right angle to the body, and the surgeon, standing outside the right and inside the left limb, with finger and thumb of left hand marking the site of intended bone section (Fig. 29), enters the knife on the side of the limb farthest from him, carries it first down 3, 3½, or 4 inches, according as he is going to make one flap longer than the other or not,‡ then across the limb, with square edges, and up the side nearest to him to the point opposite to that from which the incision started. Next, passing the knife under the limb, he marks out a posterior flap, usually somewhat shorter than the anterior. These flaps, consisting of skin and fasciæ, are then dissected up, the muscles cut through at the flap-base with a circular sweep, and the bone sawn through as high as possible. Especial care should be taken here, as in forearm amputations, to divide the nerve-trunks square and high up.* In tying the main arteries, each must be thoroughly separated from its accompanying nerve.

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* On this point Dr. Otis writes (*loc. supra cit.*, p. 811), "The surgeons, doubtless, sometimes yielded to what John Bell called 'an argument of necessity as well as of choice, and limbs, that in happier circumstances might have been preserved, had often, in a flying army or a dangerous campaign, to be cut off,' since 'it is less dreadful to be dragged along with a neat amputated stump than with a swollen and fractured limb, where the arteries are in constant danger from the splintered bones.'"

† With an Esmarch usually; in amputation high up, either the axillary must be controlled by elastic tubing applied by a modification of the method given at p. 113, or the subclavian must be controlled by a reliable assistant.

‡ If the flaps are cut of equal length, the cicatrix will be opposite, and perhaps adherent to, the bone; this is very undesirable, though of less importance in a stump of the upper than of the lower extremity

(*b*) LATERAL FLAPS.—This method may be made use of, one flap being cut longer than the other, when the skin is more damaged on one side.

The surgeon, standing as before, marks the site of bone-section by placing his left forefinger and thumb, not now on the two borders of the arm, but on the middle of the anterior and posterior surfaces of the limb. Looking over, he enters his knife at the latter spot, and cuts a well-rounded flap, ending on the middle of the anterior aspect, and then, from this point, without removing the knife, another flap is marked out by a similar incision ending at the middle of the back of the arm. The flaps are then dissected up, and the operation completed as before.

ii. **Transfixion Flaps, usually Antero-posterior** (Fig. 28).—In an arm of moderate size, or in cases where rapidity is required, as in warfare or in cases of double amputation, this method may be made use of. The surgeon, standing as before,† and with his left hand marking the flap-base, and lifting up the soft parts in front of the humerus so as to get in front of the brachial vessels, and thus avoid splitting them, sends his knife across the bone and in front of the above vessels, and makes it emerge at a point exactly opposite ; he then cuts a well-rounded flap, about 3 inches long, with a quick sawing movement, taking care, after he feels the muscular resistance cease, to carry his knife on a little, so as to cut the skin longer than the muscles, the knife being finally brought out quickly and perpendicularly to the skin. The flap being then lightly raised, without forcible retraction, the knife is passed behind the bone at the base of the wound already made, and a posterior flap cut similar to the anterior, but somewhat shorter. Both flaps are then retracted, any remaining muscular fibres divided with circular sweeps of the knife, and the bone exposed a little above the junction of the flaps. The saw is then applied after careful division of the periosteum. The brachial artery will either be found in the posterior flap, or if, as both flaps are made, the soft parts are drawn a little from the humerus, the main artery and nerves will be left, and must be cut square with the circular sweeps of the knife.

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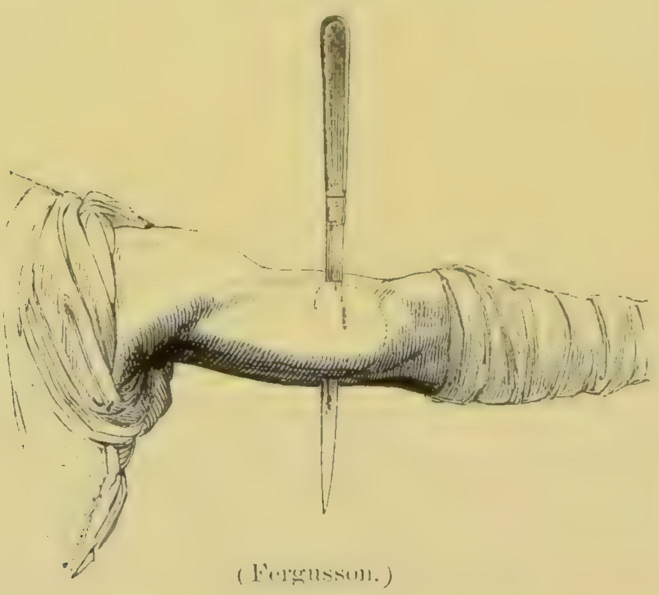
* In an amputation which passes through the musculo-spiral groove, great care must be taken to divide completely the nerve lying in this, before the bone is sawn. The depth of this groove varies much. When it is considerable, the nerve may easily escape division and be frayed by the saw, giving rise, if overlooked, to a most painful, bulbous end.

† In Fig. 28 the surgeon is supposed to be standing outside the left arm.

FIG. 28.

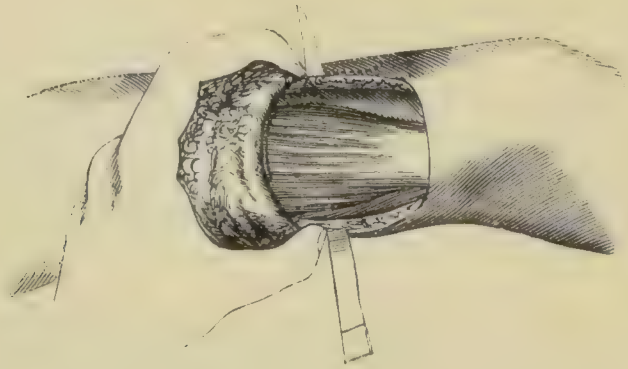


(Fergusson.)

If it be preferred, lateral flaps can be made by transfixion (Fig. 28), one of course being cut longer than the other if this is rendered desirable by the condition of the soft parts.

iii. **Combined Skin and Transfixion Flaps** (Fig. 29).—This, a very speedy and efficient method, may be made use of here. An anterior flap of skin and fasciæ, about 3 inches long, having been marked out (p. 88) and dissected up, the bulk of the soft parts behind the bone are drawn a little away from it,

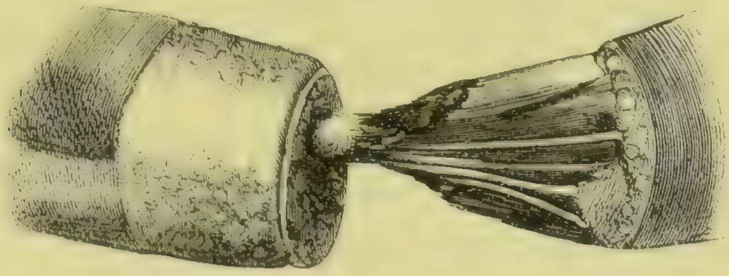
FIG. 29.



the knife passed behind the humerus, and a posterior flap, somewhat shorter, cut by transfixion.

iv. **Circular** (Fig. 30).—Owing to the moderate size of the limb, and its circular shape, this is the place, above all others, where this method can be made use of, especially in limbs which are not very bulky. Whether he make use of it in after-life or no, the student should always perform a circular amputation here on the dead subject.

FIG. 30.



Standing as before, or on the outer side of either limb, the surgeon, with his left hand, draws up strongly the skin, and passes his knife under the arm, then above, and so around it, till, by dropping the point vertically, the back of the knife looks towards him, and the heel rests on the part of the arm nearest to him. A circular sweep is then made round the limb, the completion of this being aided by the assistant in charge of the limb, who should rotate it so as to make the tissues meet the knife. A cuff-like flap of skin and fasciæ* is then raised, for 2½ or 3 inches, with light touches of the knife, and, having been folded back, the muscles are cut through close to the reflected skin.† The cut muscles are next retracted by the operator's left hand, and the remaining soft parts, with the main vessels and nerves, are severed clean and square.‡ The bone is then freed for ¾ inch, and the periosteum, having been divided, is sawn through as high as possible.

v. Single flap. This, preferably an anterior, is cut by transfixion, and so arranged, if possible, as not to include large nerves (Malgaigne).

vi. Teale's method. This is, however, expensive of important parts.

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[*] See foot-note, p. 51.

[†] By some it is advised to cut the biceps rather longer than the rest, owing to its retracting more, as it is not attached to the humerus.

[‡] See the remarks (foot-note, p. 89) on the importance of securing thorough and clean division of the musculo-spiral nerve when the amputation passes through the groove.

Height of Section of the Bone.—If possible, the head of the humerus should always be left *in situ*. This not only leaves a far more shapely stump, but, as pointed out by Farabeuf quoting from Percy, it furnishes a useful point of attachment for an artificial limb, and one well fitted to bear pressure in certain occupations. Farabeuf (*loc. supra cit.*, p. 350) alludes to the necessity of preserving, in amputations high up, some part of the insertion of the pectoralis major in order to counteract the tendency of abduction of the stump.

EXCISION IN CONTINUITY OF THE SHAFT OF THE HUMERUS.

This operation has been especially discussed in reference to gunshot wounds. By the term "excision in continuity," deliberate removal of portions of the shaft of the humerus—*e.g.*, 2–6 inches—the periosteum being preserved as far as possible is meant; such operations as incision and removal of splinters, operations for necrosis and for pseudo-arthrosis, should be excluded.

Dr. Otis* thus writes of this operation: "I cannot discern that the experience of the war lends any support to the doctrine of the justifiability of operations of this nature except in very exceptional cases. The numerical returns, and the necessarily abbreviated summaries, may appear, at first glance, to represent the results in a favourable light, but a more precise analysis reveals most lamentable conclusions. . . . The mortality rate is nearly double that observed in the cases treated by expectant measures, and more than 12 per cent. higher than the fatality in a larger series of primary amputations in the upper third of the arm. Moreover, in the 477 cases of recovery there were no less than 99 instances in which 'no bony union' was reported, and 65 others recorded as examples of 'false joint.' There were also amongst the cases reported as 'successful' 37 instances of consecutive amputation of the arm. Recourse was had to ulterior exarticulation or amputation in 64 patients, of whom 27 perished.

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* *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 695 *et seq.* In Circular No. 3, p. 223, seven "successful" cases are briefly reported. In one of these, two months after the removal of 3 inches of the shaft (the operation being performed for caries a year after a gunshot injury), bony union had taken place, the functions of the hand and arm were well performed. The patient could lift 8 or 10 lbs., and the arm was still becoming stronger. The bone removed is said to have been completely denuded of its periosteum in its entire circumference, this membrane being probably thickened.

"Such evidence warrants the assertion that early excision in the continuity of the humerus after injury can seldom be justifiable, a conclusion at which European surgeons had already arrived from the experience of the Schleswig-Holstein and Danish Wars, and which had been confirmed by more recent observations. The coaptation of the resected ends of the bones by silver wires was sometimes practised, with few illustrations of favourable results. Examination of the details of many of the formal primary excisions in the shaft strengthens the impression that they were for the most part unnecessary and injurious."

Causes of Failure after Excision of the Humerus in Continuity.—Amongst these are:

1. Osteo-myelitis and pyæmia.
2. Secondary hæmorrhage.
3. Secondary necrosis.
4. Non-union, leading to a limb which dangles* or is flail-like, and is more or less useless in spite of a support.

While excision in continuity of the humerus is to be condemned as a primary operation, and while the same operation performed secondarily for necrosis may lead to a limb which is of little use without an artificial support, the following case of Dr. Macewen's† shows what ingenuity and perseverance may effect in such cases, and proves that detached portions of bone deprived of their periosteum are capable of living and growing after transplantation:—

A boy, aged two, had complete‡ necrosis of the shaft of his right humerus after suppurative periostitis. The necrosed bone was removed about nine weeks after the onset of the periostitis, leaving the layer of granulations covering the periosteum intact, and forming a tube, which was kept patent by dressings suitably inserted until the whole space had granulated up. No bone grew from the periosteum, except a small part next the proximal epiphysis, where, at the outset, the periosteum was found covered by plaques of adherent osseous tissue. From the whole of the remainder there was no osseous deposition, the result being a flail-like arm. Fifteen months subsequently he returned to the Glasgow Royal Infirmary, his parents desiring that the arm should be removed, it being worse than useless, inasmuch as he required the other hand and arm to look after the flail-like one, which was constantly dangling in the way. The condition of the arm was as follows:—The bone had not increased in length since he left the hospital. When the limb was allowed to hang by the side, the measurement, from the tip of the acromion process to the distal extremity of the humeral shaft, was nearly 2 inches. The proximal fragment was conical, and tapering from the rounded head to a narrow spike-like extremity. From this to the condyles there was a complete absence of bone, there being nothing but soft tissues in the gap. The muscular power was good, but when he attempted to raise his arm a contraction of the muscles took place, the condyles being drawn towards the proximal extremity, while some fibres of the deltoid raised the spike-like process of the upper portion, causing it to project, as if about to penetrate the skin. Here the action ceased, the soft parts in the gap appearing like a rope during the muscular contraction. He could not raise his forearm to his breast, the lever and fulcrum needed being wanting. It was determined to supply these by transplantation from other human bones. In the wards there were numerous cases of marked anterior tibial curves, from which wedges of bone had to be removed, and these were used as transplants. An incision was made into the upper third of the humerus, exposing the head of the bone. Its extremity, for fully $\frac{1}{4}$ inch, was found to be cartilaginous. The cartilaginous spike-like process was removed, leaving there a portion of bone, which measured 1$\frac{3}{4}$ inch from the tip of the acromion. From this point a sulcus, about 2 inches long, was made, downwards, between the muscles. The former presence of bone was nowhere indicated, and there was no vestige of periosteum, and the sole guide as to the correct position into which the transplant was placed was an anatomical one.[*] Two wedges of bone were then removed from the tibia of a patient, aged six, affected with anterior curves. The base of these osseous wedges consisted of the anterior portion of the tibia, along with its periosteum. After removal they were cut into minute fragments with the chisel, quite irrespective of the periosteum. The bulk of the fragments had no periosteum adhering to them, they having been taken from the interior of the bone. They were then deposited into the muscular sulcus in the boy's arm, and the tissues drawn over them and carefully adjusted. The wound healed without pus production.* Two months after, a portion of bone, 1 inch in length and ¾ inch in thickness, was found firmly attached to the upper fragment of the humerus. In moving the finger from the head of the bone towards the graft, the latter could be easily distinguished by the sudden increase in the breadth. Now. instead of the former sharp spike, the upper fragment ended obtusely. Two other wedges of bone, of larger size than the first, were similarly dealt with, and inserted two months after the first. These filled up the gap in the arm to the extent of 4½ inches, the arm then measuring 6 inches in length. Soon the utility of the arm was greatly restored.

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* There is a good illustration of this result in Fig. 506, *loc. supra cit.*, p. 682. Further details are needed of the amount of use made of, and the ultimate advantage accruing from, the ingenious apparatus of Dr. Hudson, which was supplied to many of these cases. In one (Circular 3, p. 223), the arm being unreliable owing to want of leverage, the incipient usefulness of this apparatus, supplied two years and a half after the injury, is stated to have been "highly gratifying and efficacious."

† *Annals of Surgery*, vol. vi. No. 4, p. 301.

‡ Dr. Macewen points out that it is probable that in the outset of this case the nutrient artery of the humerus was occluded or separated in the intensity of the suppurating process. The periosteum which remained, not only did not produce bone, but fifteen months later appeared to have been completely absorbed.

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[*] *I.e.*, the only guide was by recognizing the relative positions which the muscles ought to occupy towards the humerus.

Seven years afterwards the patient was seen and examined. The shaft of the humerus was found to have increased in length by 1¾ inch, being now 7¾ inches. it had increased in circumference to a marked extent, and had assumed a somewhat irregular shape. The patient could use his arm for a great many purposes—taking his food, adjusting his clothes, and in many games.

In some remarks on this case, Dr. Macewen advances the following arguments against the supposition that the new bone grew from old periosteum :—(1) If any of this had existed and possessed osteogenic power, it had ample time to reveal itself by osseous growth during the fifteen months which had elapsed between the removal of the dead bone and the transplantation of the new. (2) In opening the sulcus between the muscles for the reception of the transplants no periosteum or anything like fibrous membrane was seen. (3) The growth of the bone was at first only commensurate with the insertion of the transplants, there being no indication of any osseous growth in the vicinity of these which might have arisen from the supposed stimulation of the periosteum. (4) The solid humerus still retains the irregularities of shape which the transplants were permitted to assume in the tissues.

Dr. Sexton records (*Med. and Surg. Reporter*, Philad., Mar. 29,

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* The importance of this statement, and its effect upon the very happy result of the case, will not escape the reader.

1890) a case in which the entire humerus was excised in a boy, aged ten, for necrosis following a fall on the shoulder. There was marked bone disease up to and involving the head of the humerus. The structures half-way down the arm were all infiltrated. Severe chorea gradually set in. In order to excise the head and as much of the shaft as was diseased, an incision 6 inches long was made from the acromion. The head was thrust out of the wound and the shaft sawn through about its middle. The bone below being evidently diseased, the incision was prolonged to the outer condyle, and the entire humerus removed. The wound healed well. The chorea, which returned less violently after the operation, was well ten days later, and in thirty days the boy began to move his arm. Four months after the operation, though the wound was healed, there was no sign of bony growth. There was 2 inches shortening; the circumference was greater than on the sound side; motion of fingers was perfect; "can lift to good advantage and dress himself, this retention of valuable power of wrist, hand, and fingers being apparently due to shortening, thickening, and strengthening of the muscles."

OPERATIONS ON MUSCULO-SPIRAL NERVE.

Suture of this nerve after injuries to it in different parts of its course is referred to p. 97, and again under the heading of "Nerve-suture."

There is another lesion to which this nerve is, owing to its close connection with the shaft of the humerus, occasionally liable after fracture of that bone—viz., compression by callus.* M. Ollier† many years ago recorded a case of this kind successfully treated by surgery. A man, aged twenty-two, had suffered a compound fracture of the right humerus, through the musculo-spiral groove. Four months later, the fracture having firmly united, the extensors of the wrist and fingers were completely paralysed, and sensibility along the course of the radial was much diminished. The integrity of the functions of the triceps seemed to show that the lesion must be seated below the commencement at the musculo-spiral groove, where the branches to that muscle are given off. M. Ollier concluded that the nerve was compressed either by one of the fragments or by exuberant callus. Prolonged treatment directed towards the removal of the callus having failed, the patient was submitted to operation. An incision having been made in the presumed direction of the nerve, so as to expose it in the external intermuscular septum, it was found by tracing a branch upwards. A gutter was next cut with chisel and mallet for 1½ inch through the callus, this step exposing the nerve, swollen and hypertrophied in its lower part, and, above, strangled (as if by a ligature) by a point of bone apparently belonging to the lower fragment. This point being cut off, and a probe passed behind the nerve to secure its complete isolation, the nerve was then followed for ½ inch above and below the bony canal, so as to ensure its liberation, and, in order to obviate any reproduction of bone, the periosteum was removed all round. The nerve was not disturbed from its gutter for fear of contusing or stretching it. The wound healed rapidly. From the sixth day the patient experienced some pricking sensations on the back and outer part of the forearm, and sensibility began to increase in the thumb and forefinger. On the twentieth day he could raise his hand a little by voluntary efforts, and when he left the hospital, six months and a half after the operation, he insisted on going back to his work in the fields.

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* The occasional abundance of this callus may, perhaps, be in part accounted for by the great thickness of the periosteum of the humerus.

† *Syd. Soc. Bien. Retr.*, 1865, 1866, p. 294; *Gaz. Hebd.*, 1865, p. 515.

A second case of this nature occurred in the practice of M. Trélat, and a third has been recorded by M. Tillaux.* The patient was a man of fifty, who had fractured the middle of his humerus without any lesion to the nerves at the time. When the splints were removed there was complete paralysis of the extensors. Four months after the accident, M. Tillaux operated to free the nerve from the pressure of the callus. The trunk of the musculo-spiral was easily discovered by an incision made below the fracture, between the brachialis anticus and the supinator longus. The nerve was then followed up, set free from the fibro-bony material which surrounded it, and the bony edges of the gutter were removed with the chisel. Three months after the operation the patient was completely cured.

Mr. Lucas (*Guy's Hosp. Repts.*, xlvi. p. 1) records two cases of division of this nerve by stabs. In one case, a lad aged sixteen, the axillary vein and superior profunda were wounded as well, the musculo-spiral nerve was divided, and its lower part torn and notched. The damaged part was cut away, and the ends united by two catgut sutures. Complete recovery followed, about three months after the injury. The other case came under care about two months after the injury, the scar being 5 inches from the acromion, opposite the insertion of the deltoid, rather behind the line of the humerus on the outer side. On laying bare the nerve it was found that there was a high division into radial and posterior interosseous, the latter being completely severed just after its origin. The musculo-spiral just before its division, and the radial at its commencement, were involved in dense scar tissue. They "were relieved" from this, and the ends of the posterior interosseous being resected, were united by fine catgut. The arm gradually improved with three months' galvanism, and a complete cure followed.

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* *Traité d'Anatomie topographique*, p. 511.

CHAPTER VI.

OPERATIONS ON THE AXILLA AND SHOULDER.

LIGATURE OF AXILLARY ARTERY (Figs. 31, 32, and 33).

Indications.

1. Wound of the artery.*
2. Aneurism of the brachial high up.†

More rarely still—

3. As a distal operation for aneurism of the subclavian.
4. Very occasionally, as the old operation after rupture of the axillary artery in shoulder dislocations (p. 106).
5. Very occasionally, as the old operation for axillary aneurism (p. 105).
6. For hæmorrhage from malignant disease in the axilla.

These cases are extremely rare, but a good instance, and one showing the difficulty of meeting them, has lately been published by Mr. Savory (*Med. Chir. Trans.*, vol. lxix. p. 157).

Operations.—Ligature of the first and the third parts of the artery will be first described, and then the old operation.

i. **Ligature of the First Part** (Figs. 31 and 32).—This operation is very rarely performed on the living subject.‡ Owing to the depth of the vessel here, its most important and intimate surroundings, and the risk of secondary hæmorrhage from the vessels which lie so close to the knot, ligature of the third part of the subclavian is preferred if ligature be required for axillary aneurism. On the dead subject the student should always take the opportunity of tying the first part of the axillary, as it is an excellent test of anatomical knowledge and practical skill.

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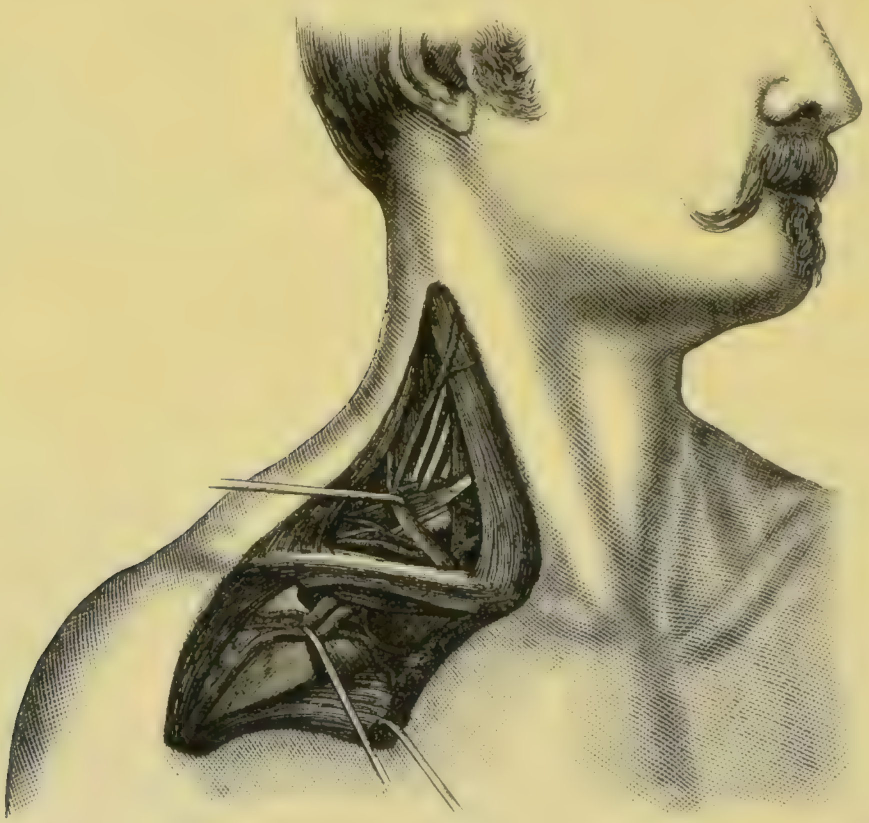
* In some wounds of the artery, the surrounding parts—*e.g.*, veins and nerves—may be so injured that the vitality of the limb is impaired beyond what ligature and nerve-suture can do, and the advisability of amputating at the shoulder-joint must be considered.

† Dr. Holt (*Amer. Journ. Med. Sci.*, April 1882) mentions a case (p. 385) of aneurism of the right brachial at its upper third; ligature of the axillary in its lower third; secondary hæmorrhage; ligature of the axillary artery in its upper third; cure.

‡ See the last note.

LINE.—From the centre of the clavicle (with the arm drawn from the side) to the inner margin of the coraco-brachialis.

FIG 31.



Relations of subclavian and axillary arteries. The Sterno-mastoid, Trapezius, Omo-hyoid are seen above. The blunt hook draws outwards the external jugular, which is falling into the subclavian vein. The artery is seen emerging from beneath the scalenus anticus, below the nerves. Two arterial branches pass outwards, the one close to the clavicle, the supra-scapular; the other, higher up, the posterior scapular, or transverse cervical. The Deltoid, a blunt hook depressing clavicular part of pectoralis major, the coracoid process, to which the lesser pectoral is attached, and the lower part of the costo-coracoid membrane are seen below, a blunt hook depresses the cephalic vein, and exposes the artery, which here gives off its acromio-thoracic branch. (Farabeuf.)

GUIDE.—The above line, and the inner margin of coraco-brachialis (p. 104).

RELATIONS :— IN FRONT.

Skin ; fasciæ ; fibres of platysma. Supra-clavicular nerve.
Pectoralis major (with muscular branches).
Costo-coracoid membrane.
Cephalic vein. Acromio-thoracic vessels.

OUTSIDE.		INSIDE.
Outer and inner cords of brachial plexus.	Axillary artery, first part.	Axillary vein.

BEHIND.

First digitation of serratus magnus.
First intercostal space and muscle.
Posterior thoracic nerve.

Collateral Circulation.

(*a*) If the artery be tied in its first part, and the ligature be placed above the acromio-thoracic, the vessels concerned will be the same as those which carry on the blood-supply after ligature of the third part of the subclavian (*q.v.*).

(*b*) If the artery be tied in its third part and the ligature be placed below the circumflex arteries, the anastomosing vessels will be the same as after ligature of the brachial above the superior profunda (p. 85).

(*c*) If the artery be tied in its third part, and the ligature be placed between the sub-scapular and circumflex arteries, the chief vessels concerned are:

ABOVE.		BELOW.
The supra-scapular The acromio-thoracic	with	The posterior circumflex.

(*d*) If in tying the third part of the artery the ligature be placed above the sub-scapular, the anastomoses are more numerous —viz., in addition to those just given:

ABOVE.		BELOW.
The supra-scapular The posterior scapular	with	The sub-scapular.

Operation.—The vessel may be secured in the following ways. The first two are recommended.

A. By a curved incision below the clavicle. This gives the necessary room, but has the disadvantage of dividing the pectoralis major and its large muscular branches.

B. By an incision in the interval between the pectoralis major and deltoid (Fig. 32). This method scarcely gives sufficient room, especially if the parts are displaced by effused blood, &c., and it is well to supplement the incision in the interval by one partly detaching the pectoralis from the clavicle (p. 102). While this plan involves less hæmorrhage from the pectoralis major, care must be taken to avoid the cephalic vein and acromio-thoracic branches which lie in this interval. This end is best secured, whichever method is adopted, by coming down on the artery as close to the clavicle as possible, the sheath of the subclavius being opened, and some of its fibres detached, if needful.

C. By an incision in the line of the artery—viz., one 3½–4 inches long, starting from just outside the centre of the clavicle, and passing downwards and outwards. This has the disadvantage of cutting the muscular branches to the pectoralis major, and gives less space than the first two.

A. The limb being at first abducted, the surgeon, standing between it and the body, which is brought to the edge of the table, makes a curved incision, with its convexity downwards and about ½ inch from the clavicle, reaching from just outside the sterno-clavicular joint to the coracoid process, the knife being used lightly at the outer end of the incision, so as to avoid wounding the cephalic vein and branches of the acromio-thoracic vessels. The clavicular origin of the pectoralis major is then divided in the whole extent of the wound, and any muscular branches which require it tied or twisted at once. The cellular tissue beneath the muscle being next explored with tip of finger and director, the upper border of the pectoralis minor is defined, and this muscle drawn downwards. The costo-coracoid membrane must next be most carefully torn through close to the coracoid process, which is a good guide, by means of a fine-pointed steel director, the cephalic vein and acromio-thoracic vessels being most scrupulously avoided. The wound all this time must be kept dry, and, if needful, a large laryngeal mirror may be usefully employed in throwing light into the bottom of the deep wound. The pulsation of the artery being felt for in the living, and its flattened cord-like feel made out in the dead subject, the sheath is exposed,* and the vessel itself carefully cleaned and separated from the vein, which lies below and in front, and from the brachial cords, which are above the artery. The needle should be passed from below so as to avoid the vein.†

B. By an incision made between the pectoralis major and deltoid (Fig. 32).

The limb and the surgeon being in the same position as in the operation just given, an incision is made obliquely downwards and outwards between the above muscles, commencing at the clavicle opposite to the coracoid process. Care being taken to avoid the cephalic vein and branches of the acromio-thoracic vessels, the muscles are separated, and, to gain more room,‡ a transverse incision is made running inwards along the lower border of the clavicle, and detaching as much as is required of the clavicular origin of the pectoralis major. This flap can be turned inwards and downwards without any interference with the nerve-supply of the muscle, and, owing to its high division, less hæmorrhage is met with by this method. The deltoid being strongly drawn outwards with a retractor, the upper border of the pectoralis minor is defined, and the operation completed as in the account already given, the parts being relaxed at this stage by adduction of the arm.

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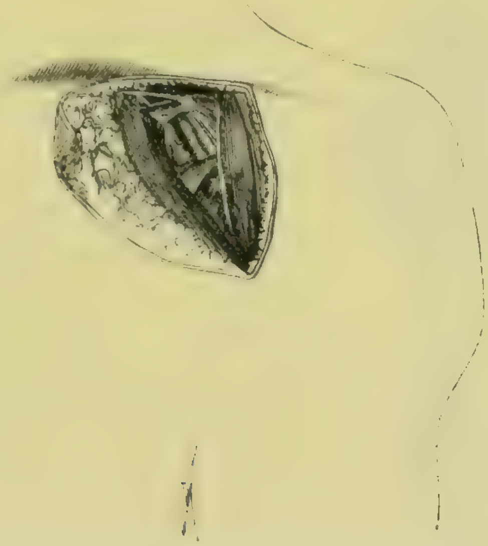
* The parts may now be advantageously relaxed by adducting the arm.

† The patient must be prepared for probably weakened or limited use of his limb for some time, at least, after the main arterial trunk has been ligatured.

‡ This step is advocated by Mr. Rivington (*Brit. Med. Journ.*, 1885, vol. i. p. 1040).

FIG. 32.



Part of the clavicular origin of the pectoralis major has been turned inwards with the flap of skin. The costo-coracoid membrane is seen cut above and below the artery, in the latter case being turned down over the pectoralis minor.

The cephalic vein runs up along the inner edge of the deltoid; another vein lies on the cords of the brachial plexus above the artery, while some other veins cross the upper part of the wound.

ii. **Ligature of the Third Part of the Axillary Artery** (Fig. 33).

LINE.—From the centre of the clavicle with the arm drawn from the side to the inner margin of the coraco-brachialis.

GUIDE.—The above line. A line drawn from the junction of the middle and anterior thirds of the axilla, along the inner border of the coraco-brachialis.

RELATIONS :—

IN FRONT.
Skin ; fasciæ.
Pectoralis major.

OUTSIDE.
Musculo-cutaneous, median. Inner border of coraco-brachialis.

Axillary artery, third part.

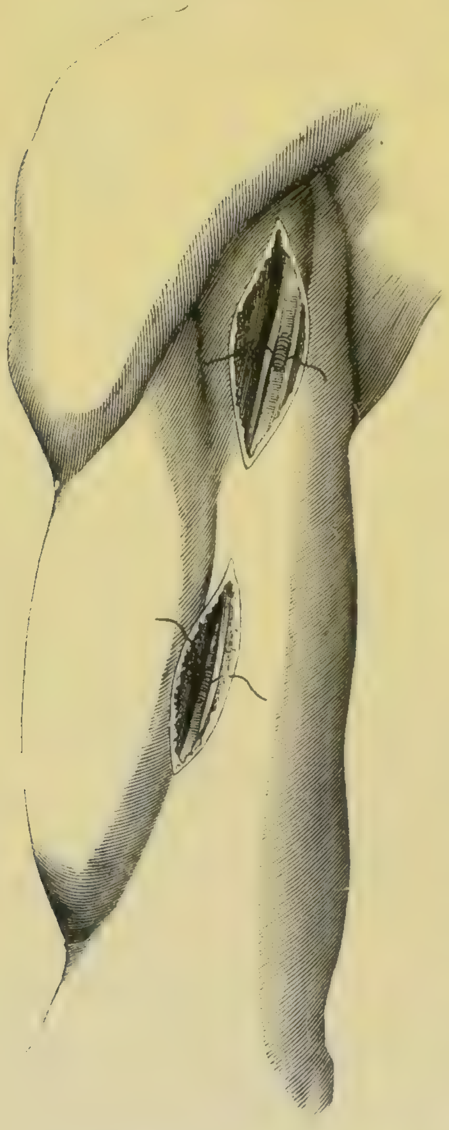
INSIDE.
Internal cutaneous; ulnar. Axillary vein or venæ comites.

BEHIND.
Sub-scapularis. Latissimus dorsi. Teres major.
Circumflex. Musculo-spiral.

Operation (Fig. 33).—This resembles somewhat that for ligature of the brachial in the middle of the arm. As with the brachial, so with the axillary here; though the vessel is comparatively superficial, it is not an easy one to hit off at once, owing to the numerous surrounding nerves, which may resemble the artery closely, especially if blood-stained.

The axilla being shaved, the arm being extended from the side and rotated slightly outwards (not too forcibly, as this will alter the relations), the surgeon, sitting between the limb and the trunk, makes an incision, 2½ or 3 inches long, at the junction of the anterior and middle thirds of the space along the inner border of the coraco-brachialis (Fig. 33). The incision may be begun above or below, as is most convenient. Skin and fasciæ being divided, and the point of a director used more deeply, the coraco-brachialis is identified, and the axillary vein and the median nerve are distinguished from the artery, the former drawn inwards and the latter, together with the coraco-brachialis, outwards.* The artery is then made sure of, cleaned, and the needle passed from within outwards, the neighbourhood of any

FIG. 33.



The lower incision shows ligature of the brachial in the middle of the arm (p. 86). The artery is immediately internal to the inner edge of the biceps, the median nerve having crossed the vessel rather high up.

In the ligature of the third part of the axillary, the artery, with the median nerve on the outer and the ulnar on the inner side, lies just internal to the coraco-brachialis. In both the operations too much of the nerves is shown.

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* Farabeuf (*loc. supra cit.*, p. 44) gives the following directions for making sure of the artery. 1. Make an incision running just behind the anterior wall of the axilla. Identify the coraco-brachialis by opening its sheath. Draw it outwards, and with the finger of the left hand sunk in the wound, depress the whole bundle of vessels and nerves. The first cord which escapes upwards, when the finger is withdrawn a little, is free, perforating no muscles, this is the median. Isolate it and have it drawn outwards with the coraco-brachialis. The second large cord uncovered by withdrawing the first is the artery.

large branch, such as the sub-scapular or the circumflex, being avoided, and the needle being kept very close to the artery.

iii. **Old Operation of Ligature of Axillary Artery for Some Cases of Axillary Aneurism and Injured Axillary Artery.**—This method may be made use of in the following instances:—

1. Where pressure has failed in the above cases.
2. Where pressure is unsuitable owing to the rapid increase, and large size, of the aneurism; the condition of the parts over it; or the inability of the patient to bear pain.
3. Where, owing to the displacement of the clavicle, ligature of the subclavian is not likely to be practicable, or where the condition of the coverings of the aneurism is such that this step, even if carried out, will not avert suppuration, sloughing, &c.

Prof. Syme (*Observations in Clin. Surgery*, p. 140 *et seq.*), holding that the old method would certainly remedy cases not amenable to ligature of the subclavian, and that even in cases where the latter is practicable the former might be preferable, made use of it in three cases, the patients being aged fifty, forty-seven, and about fifty respectively. In the first case, the skin in the neighbourhood of the shoulder-joint was dusky red and vesicating, and the patient beginning to wander in his mind. In the third, after the operation, delirium tremens set in, with excessive suppuration and sloughing of the tissues of the limb. All three recovered.

The following is the account of the operation in Prof. Syme's words (*loc. supra cit.*, p. 148):—"I made an incision along the outer edge of the sterno-mastoid through the platysma myoides and fascia of the neck, so as to allow a finger to be pushed down to the situation where the subclavian lies upon the first rib. I then opened the tumour,* when a tremendous gush of blood showed that the artery was not effectually compressed; but while I plugged the aperture with my hand, Mr. Lister, who assisted me, by a slight movement of his finger, which had been thrust deeply under the upper edge of the tumour and through the clots contained in it, at length succeeded in getting command of the vessel. I then laid the cavity freely open, and with both hands scooped out nearly 7 pounds of coagulated blood. The axillary artery appeared to have been torn across, and, as the lower orifice still bled freely, I tied it in the first instance, next cut through the lesser pectoral muscle close up to the clavicle, and, holding the upper end of the vessel between my finger and thumb, passed an aneurism needle so as to apply a ligature about $\frac{1}{2}$ inch above the orifice. The extreme elevation of the clavicle, which rendered the artery so inaccessible from above, of course facilitated this procedure from below. Everything went on favourably afterwards."

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* In one of his cases, while laying open the cavity, Prof. Syme had to avoid the radial artery, which ran over the surface of the sac.

Sir J. Paget and Mr. Callender (*St. Bartholomew's Hosp. Repts.*, vol. ii.) made a ⊣-shaped incision, cutting parallel with the lower margin of the pectoralis major, and a second at right angles to the first straight up through the whole width of the pectoralis major.

A short space may be allotted here to that most important accident which has happened to so many surgeons—viz., rupture of the axillary artery while dislocations of the shoulder are being reduced. Of late years the great fatality which the old operation has met with here has been pointed out. Dr. Stimson (*Ann. of Surg.*, Nov. 1885) draws the following conclusions from forty-four cases:—"Conservative treatment—viz., complete rest with direct pressure—may properly be tried at first, especially if the tumour is small, recent, and not increasing, but should not be prolonged if the symptoms do not promptly yield; and, secondly, in case of resort to operation, ligature of the subclavian or disarticulation at the shoulder is to be preferred to incision of the sac and double ligature of the artery." Of seven cases of double ligature of the artery, all were fatal. Of fourteen of ligature of the subclavian, five recovered. Without operation, thirteen died, six recovered. Of four cases of amputation at the shoulder, only one recovered. Repeated puncture is always fatal. Körte, of Berlin (*Arch. f. klin. Chir.*, Bd. xxvii. Hft. 3, quoted by Dr. Stimson), is of opinion that in many cases the injury to the artery is caused at the time of the accident, but hæmorrhage does not come on till after reduction is brought about, as the vessel is compressed by the head of the bone. As to the exact cause of the injury to the vessel when it takes place at the time of the reduction, it is probable that some special condition exists to account for it, as so many old dislocations are reduced with much force, used with impunity—*e.g.*, atheroma; adhesion of the artery to the head of the bone; too great or misapplied force in reduction, viz., use of the boot, in elevation; projection of a fragment or a spicule of bone. It is usually the axillary artery, or one of its branches, which gives way; much more rarely (four out of forty-four cases), the axillary vein.

The following remarks with which Mr. Holmes [*] (Hunterian Lectures) summed up the treatment of axillary aneurism are well worthy of thoughtful perusal:—

"1. There are a great number of these aneurisms, both traumatic and spontaneous, which are amenable to gradual intermitting pressure when carefully applied to the artery above the tumour.

"2. That in cases where this is not possible, from the pain which the person experiences on pressure, the application of rapid total compression under anæsthesia may effect a cure.

"3. That the ligature of the subclavian is so dangerous an operation, both from its own risks and the proximity of the sac, that it ought to be restricted to cases where pressure has failed, and to those in which, from the size and rapid growth of the axillary swelling, the surgeon thinks pressure unadvisable.

"4. That the old operation is to be preferred to ligature of the subclavian in cases of ruptured artery, and that it may be practised in cases where, from the elevation of the shoulder or from the extent of the swelling, the surgeon would find it difficult to tie the subclavian, or fears, in doing so, to injure the sac, but that the anatomical relations of axillary aneurisms render this a peculiarly hazardous proceeding, and the surgeon should always be prepared to amputate if necessary.

"5. That in very large axillary aneurisms, if any treatment be adopted, the arm should be amputated at the shoulder-joint [†] after ligature of the subclavian."

AMPUTATION AT THE SHOULDER-JOINT.

Indications.

i. Compound comminuted fractures—*e.g.*, railway and machinery accidents.

ii. Gunshot injuries.—Amputation here is divided by Dr. Otis [‡] into—(1) Primary, or before the third day; (2) Intermediary, or cases in which the operation was performed between the third and the thirtieth days; and (3) Secondary, in which the operation was performed later than the thirtieth day.

(1) Primary.—The mortality here was 24 per cent. The indications for amputation so soon after the injury are chiefly—(*a*) A limb torn off partially, but too high to admit of any

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[*] *Lancet*, September 27, 1873.

[†] P. 109.

[‡] *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 613 *et seq.*

other amputation; (*b*) Severe comminuted fracture of the upper end of the humerus, with extensive injury to the vessels and nerves; (*c*) Such a fracture high up, with severe splintering extending down below the insertions of the pectoralis major and the latissimus dorsi.*

(2) Intermediary.—The mortality here, 45 per cent., was nearly double that of the primary. This seems to have been brought about largely by the fact that the operation was now performed through soft parts, the seat, at this time, of unhealthy inflammation, and thus prone to lead to secondary hæmorrhage, pyæmia, sloughing, &c.

(3) Secondary.—The causes for this deferred operation were chiefly hæmorrhage, gangrene, profuse suppuration, hopeless disease of the humerus, sometimes with consecutive implication of the joint, chronic osteo-myelitis, or necrosis of the entire humerus. The mortality was 28 per cent.

From the above it is evident that the necessary examination should be made, and the operation performed, as soon after the injury as possible, consistent with the state of the patient, the difference between operating in sound and diseased parts, and the neighbourhood of the joint to the chest, if a septic condition of the wound sets in, being borne in mind.

iii. New growths.—If these involve the scapula or its processes, amputation at the shoulder-joint should be combined with removal of the scapula (p. 143).†

iv. Disease of the shoulder-joint unsuited for, or persisting after failure of, excision.

v. For osteo-myelitis and necrosis of humerus resisting other treatment, or complicated with early blood-poisoning.

vi. For rapidly spreading gangrene or gangrenous cellulitis with threatening septicæmia.

Mr. Heath (*Clin. Soc. Trans.*, vol. xiv. p. 114) has recorded such a case in which this amputation was needed to save life. A nurse had pricked her finger deeply with a pin hidden in some of the clothes of a lady who had died of virulent puerperal septicæmia; gangrenous cellulitis rapidly set in, and extended in spite of incisions; on the sixth day the gangrene appeared to be arrested in the forearm, though there was a blush of advancing mischief up the arm. In the afternoon of the same day sudden extension took place, and Mr. Heath removed the arm at the shoulder-joint, the patient ultimately making a good recovery.

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* In some of these the adoption of the Furneaux-Jordan method (p. 122) might lead to diminished loss of blood.

† The question of the possibility of saving the limb and removing the growth by excision of the head of the humerus is considered at p. 126.

The operation chosen was by outer and inner flaps, the former giving a fairly healthy flap of deltoid, the latter having to be cut very short owing to the infiltration of the axilla. The dressings became offensive, but the stump healed well.

vii. Amputation at the shoulder-joint may be called for in the following cases of aneurism :—

A. In some cases of subclavian aneurism where other means have failed or are impracticable ; where the aneurism is rapidly increasing ; where the pain is constant and agonizing ; and where the limb is threatening to become gangrenous. While the principle of this operation appears to be physiologically sound—*i.e.*, to enable distal ligature to be performed on the face of the stump, and that, by removal of the limb, the amount of blood passing through the aneurism may be diminished—the results hitherto have not been very successful. Thus, in Prof. Spence's* case, a man aged thirty-three, with a subclavian aneurism, probably encroaching on the second, if not the first, part of the artery, with excruciating pain and threatening gangrene, amputation at the shoulder-joint was followed by diminution in the pulsation and size of the sac, but with little formation of coagula. Death took place four years afterwards, probably from extension of the aneurism to the innominate and aorta. In this case the operation, though it had but little effect in consolidating the sac, undoubtedly prolonged life, as gangrene was threatening, and the second part of the artery was almost certainly affected, thus rendering the case a most unfavourable one. In Mr. Holden's† case the patient was almost *in extremis*, and the sac gave way. In Mr. H. Smith's ‡ case an intra-thoracic portion of the aneurism also ruptured, there being no evidence as to benefit or otherwise. In Mr. Heath's § case (the aneurism being perhaps traumatic in origin, and of the false circumscribed kind) the effect on the aneurism was so transient as to be practically *nil*. Two months after the amputation, as the aneurism continued to increase in size, Mr. Heath introduced into the sac three pairs of fine sewing needles, making each pair cross within the sac. Considerable clotting took place around the needles, which were withdrawn on the fifth day. The aneurism gradually became solid, but the patient sank soon after from bronchitis. Mr. Heath concluded that amputation at the shoulder-joint for aneurism is not a satisfactory proceeding, but the majority of surgeons present were in favour of further trials of this mode of treatment if it could be resorted to early.

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* *Med. Chir. Trans.*, vol. lii. p. 306.

† *St. Barthol. Hosp. Reports*, vol. xiii.

‡ Quoted by Mr. Heath, *loc. infra cit.*

§ In a paper brought before the Medico-Chirurgical Society (*Trans.*, vol. lxiii. p. 65). For the discussion on this, see *Lancet*, 1880, vol. i. p. 169; *Brit. Med. Journ.*, 1880, vol. i. p. 205.

B. With the same objects in view, amputation at the shoulder-joint may be required in some cases of axillary aneurism complicated with extension of the sac upwards, much elevation of the shoulder, conditions which may render compression or ligature of the subclavian impossible, removal of the limb being additionally called for if agonizing pain or threatening gangrene is present.

Prof. Syme* briefly alludes to two such successful cases, in one of which gangrene was threatening: "In a case of axillary aneurism in a gentleman of about fifty-two years of age, where ligature was prevented by intense inflammation of the arm, rapidly running on to gangrene, I performed amputation at the shoulder-joint, cutting through the sloughy sides of the aneurism and tying the artery where it lay within the sac."

C. In some cases of inflamed axillary aneurism threatening suppuration, Mr. Erichsen† points out that the question of this amputation may arise. As the old operation of opening the sac, turning out the clots, and securing the vessel above and below is impossible, owing to the fact that the coats of the vessel, now softened, will not hold a ligature, two courses only are open to the surgeon—viz., ligature of the third part of the subclavian, or amputation at the shoulder-joint. While the former may be followed when the aneurism is moderate in size and when there is no evidence of threatening gangrene, amputation must be resorted to when less favourable conditions are present.

If hæmorrhage occur from an inflamed axillary aneurism which has ruptured after the subclavian has been already tied, Mr. Erichsen, of the two courses now open—viz., either to open the sac and try and include the bleeding spot between two ligatures, or to amputate at the shoulder-joint—strongly advises the latter.

The coats of the artery "in the immediate vicinity of the sac could not, in accordance with what we know to be almost universally the case in spontaneous aneurisms of large size or old standing, be expected to be in anything like a sound, firm state, and would almost certainly give way under pressure of the noose; or the vessel might have undergone fusiform dilatation, as is common in this situation, before giving rise to the circumscribed false aneurism, in which case it would be impossible to surround it by a ligature; or, again, the sub-scapular or circumflex arteries might arise directly from, and pour their recurrent blood into, the sac or dilated artery, and, as they would lie in the midst of inflamed and sloughing tissues, no attempt at including them in a ligature could be successfully made. In such circumstances as these the danger of the patient would be considerably increased by the irritation and inflammation that would be occasioned by laying open and searching for the bleeding vessel in the sac of an inflamed, suppurating, and sloughing aneurism, and much valuable time would be lost in what must be a fruitless operation, at the close of which it would, in all probability, become necessary to have recourse to disarticulation at the shoulder-joint, and thus to remove the whole disease at once."

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* *Med. Chir. Trans.*, vol. xliii. p. 139.

† *Surg.*, vol. ii. p. 217.

D. In the words of the same writer,* "there is another form of axillary aneurism that requires immediate amputation at the shoulder-joint, whether the subclavian artery have previously been ligatured or not; it is the case of diffuse aneurism of the arm-pit, with threatened or actual gangrene of the limb."

Different Methods.—Of the thirty-six different methods which have been enumerated, most will be found to differ in some unimportant detail. Five methods will be described here, which will be found sufficient, if modified when needful, for all cases. The circumstances under which this amputation is performed do not admit of any one definite method being followed. Thus after a railway accident or gunshot injury, the soft parts will be destroyed on at least one surface. In amputating for malignant disease, skin flaps must be made use of, transfixion being usually inadmissible, as the muscles should be cut as short and as close as possible to their upper attachments, to minimize the risk of extension and recurrence. Instead of remembering the length and size of differently named flaps, the surgeon will have to be familiar with the anatomy of the parts, the position of the vessels, and the best means of meeting hæmorrhage.

The joint is so well covered that sufficient flaps can† nearly always be provided, while the blood-supply is so abundant that sloughing very rarely occurs, and even if it do so, from the results of injury or hospital gangrene, the tissues of the chest will come forward sufficiently to close the wound. While the cavity of the axilla favours exit of discharges below, the abundance of cellular tissue opened up favours diffuse inflammation, and calls for adequate drainage.*

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* *Loc. supra cit.*, p. 218.

† In some cases of gunshot injury, it is necessary to get the chief flap from the axillary region, and to bring this up and unite it to the cut margin of skin over the acromion.

The following methods will be described here: in the first two, skin flaps are made; in the others (save in the Furneaux-Jordan method), transfixion is made use of, in part at least.

In all cases of doubt, as after injury, the condition of the bone, and, if needful, that of the vessels and nerves, should be first cleared up by a free incision as if for excision (Figs. 36 and 39, pp. 116 and 118).

i. By lateral skin flaps. The oval, or *en raquette* methods.
ii. Spence's method.
iii. Superior and inferior flaps.
iv. Superior or deltoid flap.
v. Anterior and posterior flaps.
vi. Furneaux-Jordan method.

While the most rapid methods are those of superior and inferior (Figs. 40 and 41), or anterior and posterior flaps (Fig. 42) in each case cut by transfixion, these require the presence of an assistant who can be thoroughly relied upon to seize the artery just before it is cut. Where there is time, and where the soft parts admit of it, one of the methods with a vertical incision—*e.g.*, *en raquette*, lateral skin flaps, or Spence's method—is far preferable, as (1) it allows of securing the artery before it is cut; (2) of exploring the condition of the head of the bone; (3) one flap can be cut longer, according to the state of the soft parts.

Means of arresting Hæmorrhage in Amputation at the Shoulder-joint.—These are mainly two:

1. Pressure on the Subclavian.—I am of opinion that the more the surgeon trusts to this plan solely, the more often will he have cause to regret it. Pressure is always liable to be inefficient in short, fat necks, and in thin patients, however well applied at first with the thumb aided by a padded key or weight, is too often rendered uncertain by the necessary changes in position of the limb during the operation, or by the pressure of assistants, a violent gush of blood at the last showing to the surgeon that his confidence in the artery being secured is misplaced.†

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* Finally, the tendency of the skin to retract when this has been much stretched, as over a large tumour, should be remembered.

† In the case of a very stout patient, a small incision might be made over the

Furthermore, an assistant so used is necessarily much in the way of the others aiding the surgeon. For the above reasons I much prefer trusting to one or other of the two next given.

2. COMPRESSION OF THE INFERIOR OR ANTERIOR FLAP, AND SO OF THE VESSELS BEFORE THEY ARE CUT (pp. 120, 122, Figs. 40, 41).

3. LIGATURING OR TWISTING THE VESSELS ON THE INNER ASPECT OF THE LIMB BEFORE THEY ARE CUT (p. 114, Fig. 35).

Farabeuf (*loc. supra cit.*, p. 355) advises tying the axillary artery (just above the circumflex branches) in the wound before severing it, as the best means of meeting hæmorrhage. He points out that, after section of the great pectoral, the anterior part of the deltoid, the lesser pectoral, and common tendon of coraco-brachialis and biceps cover in the artery, and that not until these are cut is the artery readily reached. If the ligature, from the close proximity of the sub-scapular, cannot be placed above the circumflex, the muscular branches of this artery to the deltoid will need securing also.

4. SECURING THE VESSELS LOWER DOWN, IN THE FURNEAUX-JORDAN METHOD (p. 122).

5. USE OF AN INDIA-RUBBER BAND.—This is applied after the same method as that fully given in amputation at the hip-joint. In my opinion, it is unreliable, especially in those cases of accident in which, the limb being mutilated high up, this operation is chiefly required. For in these the band, being applied under the axilla and across the body, slips up as soon as the head is disarticulated, allowing of bleeding from the vessels, and coming, itself, most inconveniently into the way of the operator.

i. **Lateral Flaps—Oval—En Raquette** (Figs. 34 to 38).—The method of lateral flaps, or the above modifications of it, are those which the student is especially recommended to practise, on account of the advantages already given.

The methods of arresting the hæmorrhage are given above. The patient being propped up sufficiently, brought to the edge of the table, and rolled over to the opposite side, the surgeon,* standing outside the abducted limb on the right side, and inside it on the left, and having marked with his left forefinger and thumb a point just below and outside the coracoid process, and a corresponding

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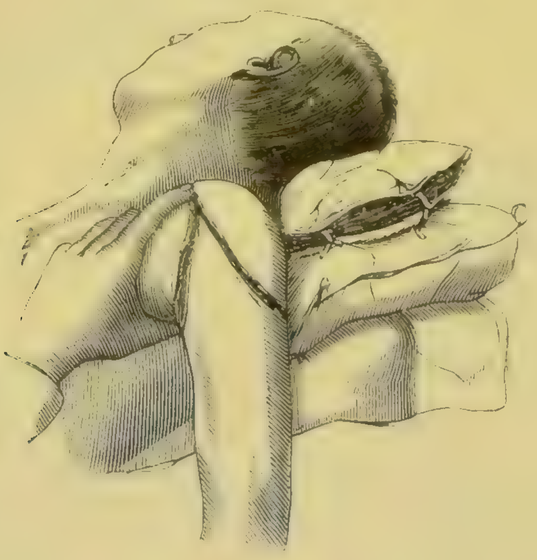
third part of the subclavian, as at p. 105, to enable a finger to be placed upon the vessel.

* Three assistants are required here—(1) To manipulate the limb; (2) To grasp the artery in the inner or inferior flap, if desired; (3) To be ready with sponges or instruments. If the subclavian is to be controlled, this must be done by No. 3. If short-handed, the surgeon will manipulate the limb himself.

point behind in the mid-axilla (Fig. 34), then reaches over, and, entering the knife in the axilla, close to the thumb, cuts an oval

FIG. 34.



flap, about 4 inches long, consisting of skin and fasciæ, from the side farthest from him, and ending close to his finger. Without removing the knife, the surgeon next marks out a similar flap on the other side, cutting from above downwards, commencing just below the finger, and ending where the first flap began in the mid-axilla. The assistant in charge of the limb aids the above by rotating the limb into convenient position. The flaps are then dissected up and held out of the way. The vessels are next exposed, separated from the surrounding nerves, and secured, either by applying two pairs of torsion-forceps (Fig. 35), dividing the vessel between them and twisting both ends, or by passing an aneurism needle, loaded with carbolized silk or chromic gut, under the artery, and thus securing it with a ligature. The limb being then carried across the chest, the outer part of the capsule is freely opened by cutting on the head of the bone and the muscles attached to the great tuberosity thoroughly severed. The limb is next rotated outwards, and the sub-scapularis tendon severed; the biceps tendon being cut and the capsule freely opened, the joint is well opened on the inner side. The head being then dislocated,* by the assistant pressing the elbow forwards and against the side, the knife is passed from the outer side behind the dislocated head, and, being kept close to the inner side of the bone, is brought out through the structures on the inner aspect of the arm, care being taken, as the knife cuts its way out, that it does so below the point where the large vessels have been secured.

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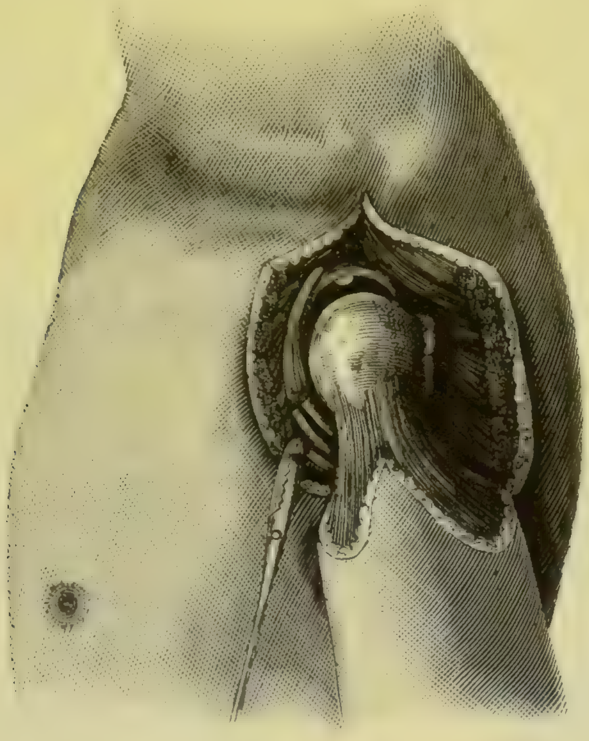
* This will only be feasible if the capsule has been deliberately and thoroughly opened. In any case where the leverage of the humerus is wanting, owing to this bone being broken high up, the use of lion-forceps will facilitate disarticulation; or the surgeon will follow the expedient of Prof. Syme, quoted by Sir J. Lister (*Syst. of Surg.*, vol. iii. p. 712), and introduce his finger into a wound in the capsule, for the purpose of drawing down the head of the bone, so as to gain access to its attachments.

FIG. 35.



Amputation at the shoulder-joint by lateral flaps. These are turned aside, while the axillary artery is secured by torsion before disarticulation is completed.

Method en Raquette with Preliminary Exploration (Farabeuf) (Figs. 36 to 38). The point of the knife being sunk just below and in front of the tip of the acromion, an incision is made downwards, sufficiently long and deep to admit of exposing the head of the humerus. If amputation is decided on, the above is converted into one *en raquette* by making an oblique incision which passes from about the centre of the longitudinal one (Figs. 36 and 37) across the inner or the outer aspect of the limb (according as it is right or left) and ends behind on a level with the lower extremity of the longitudinal one. A second exactly symmetrical to the first is next made over the opposite aspect of the limb, beginning where the first ended and terminating in the longitudinal incision opposite to the first (Fig. 36). The next step is the exposure of the artery by division of the muscles. In the curved inner incision

(Fig. 37) are seen the anterior fibres of the deltoid almost blended with the insertion of the great pectoral. This is raised with the finger, and the insertion of the great pectoral detached from the bone. If now the inner flap is folded inwards, the coraco-bicipital fasciculus comes into view. The aponeurosis over it being opened by a free longitudinal incision, the muscular fasciculus is drawn over the front of the humerus and cut across. If an assistant now thoroughly retracts the inner flap, the axillary vessels and nerves are exposed. The artery should be isolated and tied as high up as possible, so as to get above the posterior circumflex. The knife being again inserted into the outer oblique incision, the deltoid is boldly cut through as far as the back of the axilla. An assistant next retracts the outer and inner flaps, while the surgeon opens the capsule freely, rotating it as directed (p. 114). The head is next thrown out of the socket, and the knife is carried behind the head, skirting the postero-internal aspect of the humerus very closely, so as not to cut the secured artery, and finally brought out through the incision on the inner side, severing the latissimus dorsi and teres major. If the artery has not been tied, an assistant secures it between his thumb, sunk deeply into the wound, and his fingers, which are in the axilla, or by using both hands.

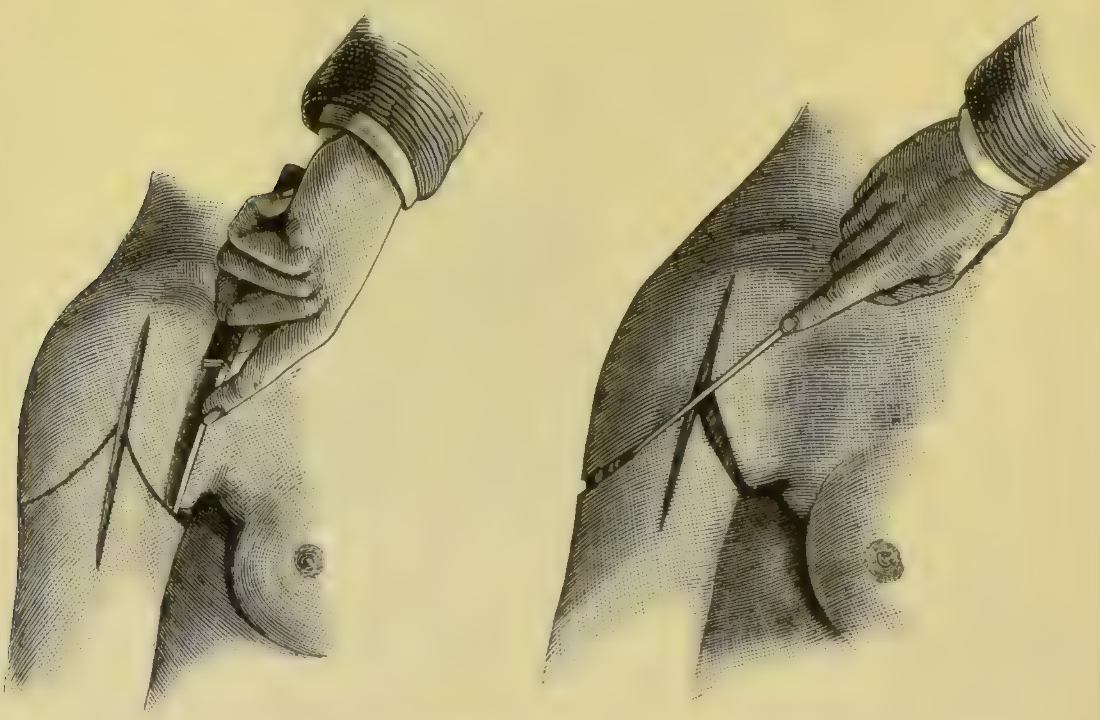


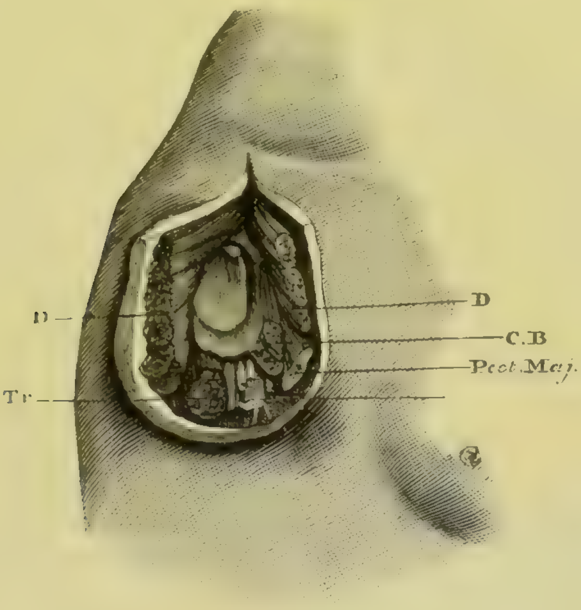
Fig. 36.

Fig. 37.

Amputation at the right shoulder-joint by the method *en raquette.* The knife is tracing the flaps, after a free exploratory incision has been made (Farabeuf).

ii. **Spence's Method** (Fig. 39).—This modification of the oval method is especially suited to cases of failed excision,* or to cases of injury—*e.g.*, gunshot—where the surgeon has to cut into and explore the condition of the joint before deciding on excision or amputation. By its means an excision can readily be converted into a disarticulation, if this step is found needful.

FIG. 38.



Parts composing the flaps made by the *en raquette* method (Farabeuf).

Other advantages, but less important ones, are—

1. The posterior circumflex artery is not divided, except in its small terminal branches in front, whereas, both in the large deltoid flap and the double flap methods, the trunk of the vessel is divided in the early steps of the operation, and, retracting, often gives rise to embarrassing hæmorrhage.

2. The great ease with which disarticulation can be accomplished.

3. The better shape of the stump. Prof. Spence points out that, however excellent are the results soon after other methods, later on the shape of the stump is much altered, not merely from the atrophy common to all stumps, but from retraction of the muscular elements of the flaps, the pectoralis major retracting towards the sternum and the latissimus dorsi and teres major towards the spine and scapula. Thus a deep, ugly hollow results under the acromion.

The operation is thus described in Prof. Spence's words:†—

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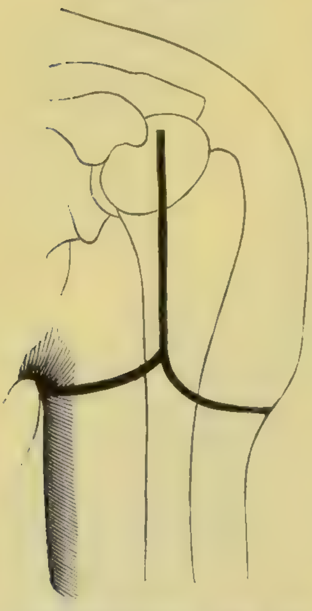
* At the present day, in cases of failed excision, the surgeon will often prefer to make use of the modification of the Furneaux-Jordan method, p. 122.

† *Lancet*, 1867, vol. i. p. 143; and *Lect. on Surg.*, vol. ii. p. 662.

"Supposing the right arm to be the subject of amputation. The arm being slightly abducted, and the head of the humerus rotated outwards if possible, with a broad strong bistoury I begin by cutting down upon the head of the humerus, immediately external to the coracoid process, and carry the incision down, through the clavicular fibres of the deltoid and pectoralis major, till I reach the humeral attachment of the latter muscle, which I divide. I then, with a gentle curve, carry the incision across and fairly through the lower fibres of the deltoid towards the posterior border of the axilla, unless the textures be much torn. I next mark out the line of the lower part of the inner section by carrying an incision through the skin and fat only, from the point where my straight incision terminated, across the inside of the arm, to meet the incision at the outer part. This insures accuracy in the line of union, but is not essential. If the fibres of the deltoid have been thoroughly divided in the line of incision, the flap so marked out can be easily separated (by the point of the finger, without further use of the knife) from the bone and joint, together with the trunk of the posterior circumflex, which enters its deep surface, and drawn upwards and backwards, so as to expose the head and tuberosities. The tendinous insertions of the capsular muscles, the long head of the biceps, and the capsule are next divided by cutting directly on the tuberosities and head of the bone, and the broad sub-scapular tendon especially, being very fully exposed by the incision, can be much more easily and completely divided than in the double flap method. By keeping the large outer flap out of the way by a broad copper spatula or the finger of an assistant, and taking care to keep the edge of the knife close to the bone, as in excision, the trunk of the posterior circumflex is protected. Disarticulation is then accomplished, and the limb removed by dividing the remaining soft parts on the axillary aspect. The only vessel which bleeds is the anterior circumflex, divided in the first incision, and here, if necessary, a pair of catch-forceps can be placed on it at once. In regard to the axillary vessels, they can either be compressed by an assistant before completing the division of the soft parts on the axillary aspect, or, as I often do in cases where it is wished to avoid all

FIG. 39.

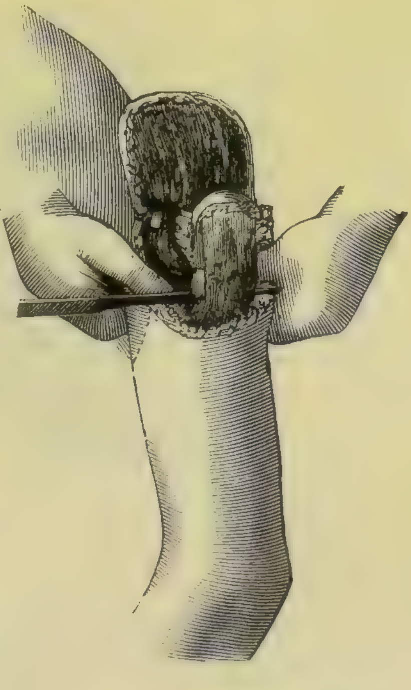


Amputation at the shoulder-joint by Spence's method. (Stimson.)

risk, by a few touches of the bistoury the vessel can be exposed, and can then be tied and divided between two ligatures, so as to allow it to retract before dividing the other textures."*

iii. **Amputation by Superior and Inferior Flaps** (Figs. 40 and 41).—The patient being brought to the edge of the table, turned sufficiently over, and his shoulders supported by pillows, the assistants are arranged as before. The arm being a little raised so as to relax the deltoid, the surgeon, standing inside the limb on the right side and outside it on the left, lifts the deltoid muscle with his left hand and sends the knife (narrow, strong, and no longer than needful) across beneath the muscle, entering it on the right side, just below the coracoid process, and bringing it out a little below the most prominent part of the acromion,† or *vice versâ*, according to the side operated upon. The knife should pass close to the anatomical neck of the humerus, without hitching upon it, and the flap should be cut broadly rounded, and well down to the insertion of the deltoid. It is then raised and retracted, and, the capsule being now exposed, the joint is opened by cutting strongly upon the head of the bone. The arm being now rotated outwards vigorously by an assistant or by the surgeon, the sub-scapularis, thus made tense, and the biceps are brought into view and severed; the limb is next rotated inwards, being carried across the chest, and the muscles attached to the great tuberosity are divided. The capsule is next still more freely opened, and the head of the bone, now freed, is pushed up by the assistant and pulled outwards from the glenoid cavity. The knife is next slipped behind the head (Fig. 40), and cuts its way along the under aspect of the neck and shaft of the humerus, so as to shape an inferior flap half the length of the upper one.‡ As soon as

FIG. 40.



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* Where the limb is very muscular, Prof. Spence recommended to raise the skin and fat from the deltoid at the lower part, and then to divide the muscular fibres higher up by a second incision, so as to avoid excess of muscular tissue.

† Unless care is taken to keep thus below the acromion process, there will be some tendency for this bone to protrude in the wound.

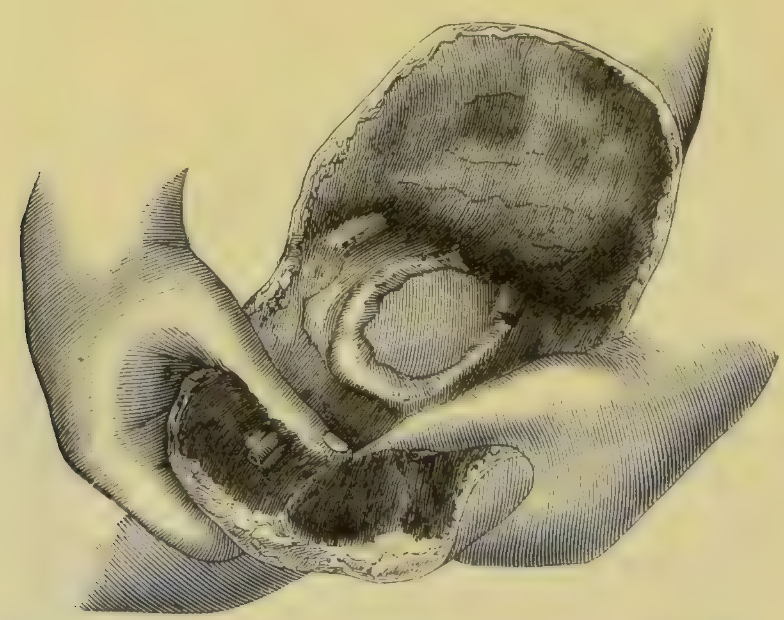
‡ The surgeon should not cut this till he is told that the flap is held firmly; and, in cutting it, he must be careful of his assistant's fingers.

the knife is passed behind the bone, an assistant slips his hands in behind the back of the knife (Fig. 40), following it so as to grasp firmly the soft parts in the inferior flap, and thus control the axillary vessels (Fig. 41).

The large vessels are next secured, then the circumflex, and any muscular branches that require it; any large nerves that need trimming are then cut short, drainage provided, and the flaps brought into position.

This amputation has the advantage of being very quickly done, and of giving a flap which keeps in position by its own weight,

FIG. 41.



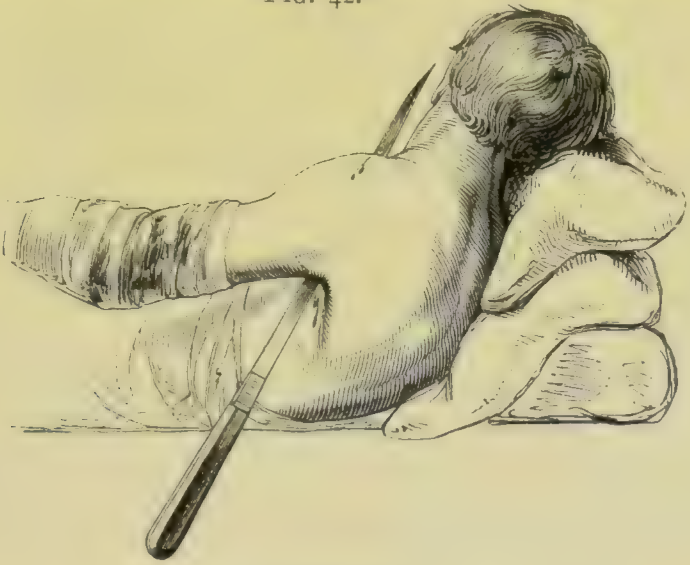
To show the manner in which bleeding is controlled in the inferior flap: the axillary vessels are compressed by one thumb, the posterior circumflex by the other.

and thus gives good drainage. If the soft parts below the humerus are much damaged, the upper flap must be cut proportionately long.

iv. **Amputation by Deltoid or Upper Flap.**—This is merely a modification of the last. The deltoid or upper flap may be cut by transfixion or made by cutting from without inwards. In either case it must be of very full size, and thus is useful when the axilla is damaged, but it has the disadvantage of leaving next to no flap in which an assistant can seize the axillary vessels; and, owing to the powerful retraction of the muscles in the axillary folds, unless the upper flap is cut full in length and size it will not cover the resulting wound. Finally, as the trunk of the posterior circumflex is cut, sloughing of the large deltoid flap may take place, especially if the tissues composing it are at all damaged previous to the amputation. Owing to these disadvantages, which outweigh its rapidity, this method is not to be recommended, a short under flap being always cut if possible. When the surgeon, having disarticulated, is cutting straight down, unable to make any flap below, assistant (2) should try to draw up the skin of the axilla, while assistant (3), in charge of the limb, should be careful not to draw down the skin, otherwise, owing to the laxity of the skin in the axilla, any downward traction will bring the skin of the thoracic wall under the knife.

v. **Amputation by Anterior and Posterior Flaps** (Fig. 42).—This is indicated when the soft parts on the front and inner aspects are damaged. The position of the patient being as before, and the limb being carried somewhat upwards, backwards, and outwards, the surgeon, standing, if on the left side, behind and outside the shoulder, enters his knife just in front of the posterior fold of the axilla, thrusts it across the back of the humerus as near the head as possible, so as to get in front of the tendons of the teres major and latissimus dorsi, and, bringing it out close to the acromion, cuts, with a sawing movement, a flap, 4 to 5 inches long,[†] which is next well retracted by an assistant. The arm being then carried across the chest, the joint is freely opened behind, the muscles attached to the tuberosities severed, the knife passed between the head and the glenoid cavity (to facilitate this, the limb should now be carried over the

FIG. 42.*



(Fergusson.)

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[*] The knife in this drawing is represented as far too large.

[†] In the posterior flap will be the posterior part of the deltoid, the latissimus dorsi, and teres major.

chest, and the head of the bone pushed backwards), then between the bone and the pectoralis major, and an anterior flap,[*] 4 inches long, cut from within outwards. Hæmorrhage from the large vessels is arrested either by an assistant grasping this flap as it is cut, much as at p. 120, or by the surgeon isolating the axillary vessels (the biceps and coraco-brachialis will guide him) and securing them by torsion or ligature (p. 116) before he completes the operation by cutting the anterior flap. When operating on the right limb, the patient being turned well over on to his left side, the surgeon, standing here inside the arm, which is held upwards and backwards so as to relax the deltoid, lifts this muscle up with his left hand, and then passes his knife from just below the acromion, transfixing the base of the deltoid, grazing the back of the humerus, and finally thrusts the point downwards and backwards through the skin till it comes out at the posterior margin of the axilla. This flap, 4 or 5 inches long, should be dissected up, the joint opened behind, and the operation completed as before.

vi. **Furneaux-Jordan Method.**[†]—This may be made use of both as a primary and a secondary amputation. The following are suitable cases :—

a. Certain cases of injury. Where, though the parts about the shoulder-joint are intact, the humerus is badly split up into the joint. The soft parts are divided down to the bone by the circular method, 3 to 4 inches below the axilla, the main vessel secured, and the humerus then shelled out by a longitudinal incision along the outer and posterior aspect of the limb, meeting the circular one at a right angle.

b. In cases of failed excision. Here, after amputation of the limb by the circular method, the rest of the bone is turned out through the excision wound prolonged into the circular one.

c. After amputation in the middle of the arm in some cases. *E.g.*, when the stump is the seat of osteo-myelitis, necrosis, or otherwise does not do well.

EXCISION OF SHOULDER-JOINT (Figs. 43 and 44).

This operation is but rarely performed—(1) owing to the comparative infrequency of diseases of the above joint, especially of pulpy disease, which usually requires operative measures ; (2) from the fact that epiphysitis and septic synovitis usually give (after free incision and drainage) as good a result as can be obtained after excision. This is mainly owing to the fact that much of the stiffness that otherwise would be present is made up for by the supplementary mobility of the scapula, especially in young subjects.*

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[*] In this anterior flap will be the remaining fibres of the deltoid, the pectoralis major, and the large vessels and nerves.

[†] For the details of this method, see "Amputation at the Hip-joint."

The above remarks naturally lead up to the consideration of *the amount of movement which is gained after the operation of excision.* The arm can never be abducted and elevated beyond the horizontal line; in the majority of cases it lies close to the chest. Even if the deltoid retained its power of elevation, it could not often exert it, as in most operations, owing to the amount of bone removed, the fulcrum of the head of the humerus against the glenoid cavity has gone. Prof. Longmore (*Resection of the Shoulder-joint in Military Surgery*, p. 12) writes:—"The loss of the elevating action of the deltoid must be accepted, like the loss of the rotating power from the division of the muscular insertions into the two tubercles, as a necessary consequence of resection of the head of the humerus. But the holding or supporting power of this muscle exerted upon the whole upper extremity owing to its position, its extensive origin, and the manner in which it embraces and protects the mutilated parts, as well as its faculty of assisting in carrying the arm backwards and forwards, are all functions which may still remain, and serve to point to the great importance of preserving its integrity as fully as possible. The wasting of the internal fibres (Fig. 43), however, seems a necessary result of resection by the single incision, but it has this compensating feature, that it is a less serious loss to the patient than an atrophied condition of the outer and posterior fibres would be, because the upper clavicular fibres of the great pectoral can take the place of the inner deltoid fibres to a considerable extent in supporting the shoulder and drawing it forwards to the chest."

Mr. Erichsen (*Surgery*, vol. ii. p. 251) says of the four natural movements of the shoulder-joint—viz., "(1) abduction and elevation, (2) adduction, (3) and (4) movements in the antero-posterior direction—these are requisite in all ordinary trades for the guidance of the hand in most of the common occupations of life. The movements of elevation are seldom required save by those who follow climbing occupations, as sailors, masons, &c. Now, the mode of performing the operation, as well as the operation itself, will materially influence these different movements. Thus, if the deltoid be cut completely across by means of an elliptical incision, the power of abduction of the arm and of its elevation will be permanently lost. If its fibres be merely split by a longitudinal incision, they may be preserved or regained in great part. All those movements of rotation, &c., which are dependent on the action of the muscles that are inserted into the tubercles of the humerus will be permanently lost; for, in all cases of caries of the head of the humerus requiring excision, the surgeon will find it necessary to saw through the bone below the tuberosities—in its surgical, and not in its anatomical, neck.* Hence the connections of the supra-spinatus and infra-spinatus, the teres minor, and sub-scapularis will all be separated, and their action on the bone afterwards lost. But those muscles which adduct, and which give the antero-posterior movements—viz., the coraco-brachialis, the biceps, the pectoralis major, latissimus dorsi, and teres major—will all be preserved in their integrity; and hence it is that the arm, after this excision, is capable of guiding the hand in so great a variety of useful under-handed movements."

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* In future, by the use of a simple longitudinal incision with a minimum of interference with the deltoid, aided by antiseptic precautions from the first, and with earlier and persevering adoption of passive movements, the above statement may have to be modified.

Indications.

i. Different forms of arthritis disorganizing the joint, resisting careful treatment, in subjects whose age, general condition, &c., are satisfactory—viz.:

(*α*) Pulpy synovitis, resisting other treatment and going on to caries.

(*β*) Disorganization of the joint after rheumatic fever, gonorrhœal rheumatism, wrenches, &c., resulting in crippling ankylosis in a young subject.

(*γ*) Ostitis going on to suppuration, caries, &c.

(*δ*) Epiphysitis, suppurating or acute necrosis, where discharge, sinuses, &c., are exhausting the patient, and the outlook as to natural cure is not good.

(*ε*) Disease of the deltoid bursa ulcerating into the joint and setting up destructive arthritis.

ii. Gunshot injuries, where the large vessels and nerves have escaped, where fragments of shell, bullets, &c., are lodged in the head of the bone, especially if the shaft of the bone is not much damaged (p. 135).

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* With all proper deference to the opinion of Mr. Erichsen, this opinion appears to be too definite and inelastic. I would refer the reader to the remarks below on the site of section of the bone, and on partial resection (pp. 131, 132).

iii. Compound dislocation and compound fracture with much damage to the capsule and cartilage of the head of the bone, the large vessels and nerves being intact.

iv. Some cases of unreduced dislocation of the head of the humerus. Mr. Holmes (*Syst. of Surg.*, vol. iii. p. 738), in a foot-note, writes: "I have often thought that, in cases of irreducible dislocation attended with much pain, the removal of the head of the bone might be justifiable, but have not met with any case in which the operation has been performed." Sir J. Lister (*Ed. Med. Journ.*, March 1873) excised the head of the humerus after securing a rupture of the axillary artery,* which vessel had given way in an attempt to reduce a dislocation of eight weeks' standing. The patient, aged fifty-eight, sank three hours later. Considering the frequency with which this accident has taken place in attempting to reduce old dislocations of the shoulder, it would be wiser, in these days of antiseptic surgery, to attempt to improve the condition of things by excising the displaced head. Mr. Sheild brought before the Medico-Chirurgical Society (March 13, 1888) a man, aged forty-five, on whom he had performed excision for a neglected sub-coracoid dislocation of twelve weeks' standing. Owing to implication of the median and ulnar nerves, the hand was almost useless. Moderate attempts at reduction having failed, the head was removed through the anatomical neck, this site being chosen in order to disturb the parts as little as possible. The end of the bone was made as like the real head as possible by careful rounding. Twelve weeks afterwards the patient was able to resume work as a waiter. The movements of the shoulder were satisfactory, and the hand gradually regained strength. Sir Joseph Lister has published (*Brit. Med. Journ.*, 1890, vol. i. p. 1) two similar cases treated by operation, but somewhat differently. They were both instances of bilateral sub-coracoid dislocation, due in the one case to a fall from a tree, in the other to epilepsy. The patients, aged forty-seven and twenty-three, were each pitiably helpless. In three of the joints, the usual incision having been made between the deltoid and pectoralis, the sub-scapularis tendon was divided, and the soft parts detached from the head of the bone and the inner side of its neck. This was done to insure the vessels being entirely set free from the head of the bone. The pulleys were next used, and the head not returning, it was protruded out of the wound, and the insertions of the external rotators cut through, after which the pulleys were used successfully. In the case of the fourth joint the head was removed. The result of these operations was "a grand success," but Sir Joseph thought that excision gave a result inferior to the other. It is noteworthy that in one case especially there was a remarkable tendency to the formation of adhesions, and the recovery of movement extremely slow. In another, the maintenance of passive movement kept up a serous oozing and delayed the healing of the wound.

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* The condition of the parts found here is most noteworthy. A broad and strong fibro-osseous band, connecting the humerus with the coracoid process, lay over the head of the bone, and at the same time was intimately connected throughout by condensed tissue with the sheath of the axillary artery, which lay over it. Thus, the vessel, instead of being surrounded by loose and yielding structures, was attached by an osteo-fibrous band to the coracoid process on the one hand, and the neck of the humerus on the other; and when these were separated from one another by the attempts at reduction, the artery as well as the band was subjected to violent traction. Accordingly, the band, strong as it was, was found to have been torn right across, and the rent in it was exactly opposite to the rupture in the artery. Atheroma in the vessel served to explain still further the disaster.

v. A few cases of growth connected with the upper extremity of the humerus. Whilst the priceless value of the hand fully justifies the attempt in some instances, such cases must be extremely rare.

Perhaps it is owing to this rarity that this matter has received so little attention.

The best reported English case with which I am acquainted is one in which Mr. Mitchell Banks* endeavoured to save the upper extremity of a patient by excising the upper end of the humerus, the site of enchondroma:—

"S. D. was a spare, placid man of fifty-six, a chapel-keeper. So far back as the summer of 1865 he was seized with violent pain near the right shoulder, and after that came a hardness and swelling at the top of the humerus, which very slowly increased. As it gave him no great inconvenience, he did not heed it much for many years, but by 1878 it had grown to be as big as a cocoa-nut, so that, on attempting to raise the arm, it became locked against the acromion, limiting movement, while pain of a severe character set in. In June 1878 the tumour was removed by cutting down upon it, and dissecting off the tissues from over it. As it grew from the outer surface of the upper third of the humerus, this was effected without difficulty. Then with a mallet and chisel it was cut cleanly away from the bone, and the surface from which it sprang was thoroughly scraped—a pretty broad surface, by-the-way. I left no cartilaginous remains that could be seen. The patient rapidly recovered, but in the tract of the wound a sinus or two persistently remained, leading down to the bone. After the lapse of about two years it became clear that the tumour was returning, and by the summer of 1881—three years after the first operation—it had attained an immense size, having taken a fit of growing during the last few months. It clearly arose from the same site as before, but now it filled up the axilla, and had even got beneath the great pectoral. Pain and rapidity of growth demanded its speedy removal. But removal of a whole right arm at the shoulder-joint seemed such a dreadful thing, that one was anxious to save a hand and forearm by carrying away, if possible, the tumour and upper part of the humerus, even although the upper arm might remain useless. The patient being made well aware that, in case of the failure of this project, there was nothing left but amputation, I attempted it. The incisions necessary to lay bare the tumour were very extensive, the chief one reaching from above the acromion, half way down the outer side of the upper arm. With much trouble, and after the loss of a great deal of blood, the outer and upper surfaces of the growth were exposed, and the humerus was disarticulated from the scapula. Then, sawing through the humerus, about 1 inch below the deltoid insertion, I attempted to dissect away the tumour from the brachial vessels and nerves. Here, however, most serious difficulty was encountered, from their intimate incorporation with the growth, and at last, after a prolonged attempt, I was reminded by my colleague, Mr. Harrison, that the patient had plainly endured as much as he could, and that to make further effort might only lead to collapse on the table. I was reluctantly compelled to admit this, and so rapidly swept the limb away at the shoulder. So profound was the shock, that a short time after the operation the temperature fell to 95°, and remained so for many hours. The operation was conducted antiseptically, and the patient, in spite of the loss of blood, made such a rapid recovery that on the twenty-third day he left the infirmary quite well, and remains so now, two years after the amputation. If the great vessels and nerves had not been so seriously enveloped by the growth, the limb would have been saved, although with the loss of the upper half of the humerus.

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* *Clinical Notes upon Two Years' Surgical Work in the Liverpool Royal Infirmary*, p. 6. It is much to be desired that this original and most instructive writer would give to the profession, with equal vigour and terseness, some more of his experience. See also a successful case of resection for a central sarcoma, Southam, *Med. Chron.*, January, 1887.

But even a forearm is better than no arm at all. The case also shows that chiselling off cartilaginous tumours is not by any means a certain removal. The surface that was left upon the humerus, after the first removal of the tumour, looked perfectly healthy to the naked eye, but there must have been cartilage cells deep down in the tissue of the bone."

Mr. J. Hutchinson has recorded* a case of resection of the upper part of the humerus for a large myeloid growth. The following is a summary of the case:—Supposed fracture of the neck of the humerus in a woman, aged twenty-seven. Permanent loss of movement and gradual enlargement above the part. Amputation at the shoulder-joint advised fourteen months after the accident, on account of a large tumour which had formed—refused by the patient. Arrest of the growth for four years. Subsequent rapid growth and enlargement of glands. Resection of the upper third of the humerus, and removal of the diseased glands. Recovery, with a useful arm, but rapid reproduction of the disease in four different parts. Death, five months after the resection, from an enormous mass, with sloughing and bleeding. Secondary growths connected with the bone, axilla, cervical glands, and lung.

In the following case,† the growth being a more innocent one, resection was more successful:—

A farmer had a swelling in the deltoid region, about the size of a hen's egg, very hard, and considered to be an exostosis. In the course of a year it grew rapidly, and the shoulder now measured 17 inches in circumference. Excision of the head of the humerus was performed, the bone being sawn through at the insertion of the deltoid, the muscles severed, including the pectoralis major and latissimus dorsi, the tendon of the biceps being preserved. Sixteen months later the patient could "plant corn as well as any man." There had been a slight reproduction of bone up to within 2 inches of the glenoid cavity, a narrow strip of periosteum having been preserved along the inner surface of the bone almost up to its neck. The shortening of the limb amounted to nearly 1½ inch. The length of bone removed, including the head, measured 3½ inches. The growth was 13 inches in circumference at its largest part, and proved to be an enchondroma.*

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* *Path. Soc. Trans.*, vol. viii. p. 346.

† Dr. Bennett, *Amer. Journ. Med. Sci.*, 1863, vol. ii. p. 385. He, quoting from Hodge's *Excision of Joints*, states that four cases of excision of the shoulder for growths are there given. Three were cases of malignant disease, and were all unsuccessful, the patient either dying soon after the operation, or later on from a recurrence. The successful case was one operated on by Mr. Bickersteth, for an exostosis which impeded the movements of the joint.

Methods.†

i. By a straight incision (Figs. 43 and 44).

ii. By a deltoid flap.

The first only need be referred to at any length here. The deltoid flap gives more room, and thus facilitates the operation considerably, but the larger scar, and far greater, in fact almost total, impairment of deltoid power are such serious drawbacks‡ that it is nowadays hardly ever used. If the head of the humerus is very much shattered, if the soft parts are much matted and thickened, if there is any special reason for completing the operation rapidly,§ this method may, though very rarely, be made use of.

The patient being rolled a little over, and the shoulder supported by a pillow, the surgeon, standing at the shoulder facing the body, with an assistant opposite to him, and another seated to manipulate the limb, makes an incision, 3 inches long, commencing just outside the coracoid process, and on a level with it, through skin and fasciæ ; the deltoid‖ is then divided for the same length, retractors inserted, and, if the arm has been rotated outwards, the bicipital groove will be seen lying at the bottom of the wound.¶

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* Further information of this case would have been very valuable. In two of the cases in which Prof. Syme excised the scapula, he had previously excised the head of the humerus. In one, the growth was fibro-cartilaginous, and recurrence did not take place for a year and three months. In the other, the nature of the growth, a cystic one, is not specified ; recurrence here also took place, about a year later.

† Fourteen different methods are figured by M. Péan, *loc. infra cit.*

‡ Prof. Longmore (*loc. supra cit.*, p. 9) says that at one time there were at Fort Pitt two patients, in each of whom resection of the joint had been performed, in one by the longitudinal, in the other by the flap, incision. In the former case, the patient could raise, without difficuty, ¾ hundredweight with the arm in an extended position by his side, and hold 14 pounds in his hand when the arm was flexed. In the latter case, all the movements of the joint were very seriously impaired. The man could not, in any degree whatever, move the arm from the side himself, nor could he flex the forearm upon the upper arm without support from the other hand.

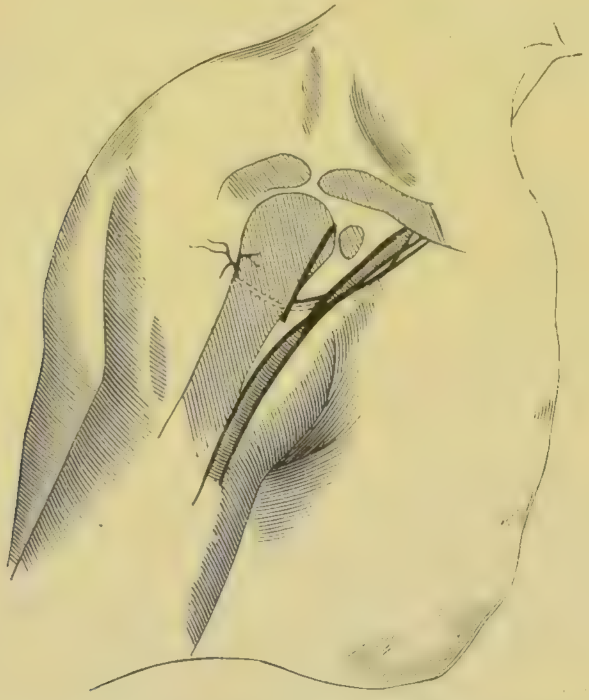
§ Perhaps, too, in the rare cases of excision attempted for large growths, for the sake of more complete exposure (p. 126).

‖ The advantage of an anterior incision starting from just outside the coracoid instead of from the acromion is that all the posterior and outer part of the deltoid (so powerful in abduction) is left intact, together with the circumflex vessels and nerve, with the exception of the terminal filaments going to the anterior part of the muscle, which alone is interfered with.

¶ Farabeuf advises, to insure the bicipital groove being found easily, that the arm be kept midway between abduction and adduction, a position secured by placing the hand (the body being horizontal) on the anterior superior spine.

The condition of this important tendon will vary much: (1) it may be normal; (2) it may be surrounded with pulpy material; (3) it may be frayed and adherent to the bone; (4) it may be ulcerated or absent. Whenever it is possible to preserve it, it should be carefully separated from its groove and drawn aside with a blunt hook. The capsule is next to be opened freely, care being taken to do this high up, over the head of the bone, and, the arm being strongly rotated outwards, the subscapularis is divided; then, after rotation inwards, the three muscles attached to the great tuberosity are cut through, and the capsule still more freely opened. In detaching the tendon and in sawing the bone, if this is done *in situ*, care must be taken, by keeping the arm somewhat separated from the body, and the elbow a little raised, to relax all the parts of the capsule. Unless this is done, the edges of the wound in the capsule are stretched tight, the finger is nipped, and there is no room for working with a saw, knife, or elevator.

FIG. 43.



Excision of shoulder-joint by a straight incision placed just outside the coracoid process. As only the anterior part of the deltoid is cut, the posterior circumflex and the circumflex nerve are less damaged. (Péan.*)

The bone may be divided in two ways:—(1) *In situ* (Fig. 44). A blunt director is passed under the bone from within outwards, so as to protect the soft parts; the bone is sawn through with a narrow-bladed or osteotomy saw, seized with lion-forceps, and twisted out, the levering movements of an elevator, or a few touches of the knife, aiding this. (2) The head is first thrust out of the wound by pushing up the elbow, and then sawn off. This method is somewhat the easier, but disturbs the soft parts more.* The former is perfectly safe, and inflicts less damage on the surrounding tissues; finally, where ankylosis is present, it may be most difficult to thrust the head out.† Whichever is adopted, the soft parts should be scrupulously protected. The truncated end of the shaft should be carefully rounded off with cutting-forceps, especially in the neighbourhood of the nerves, and Mr. Sheild's plan of trying to reproduce the shape of the old head may be tried.

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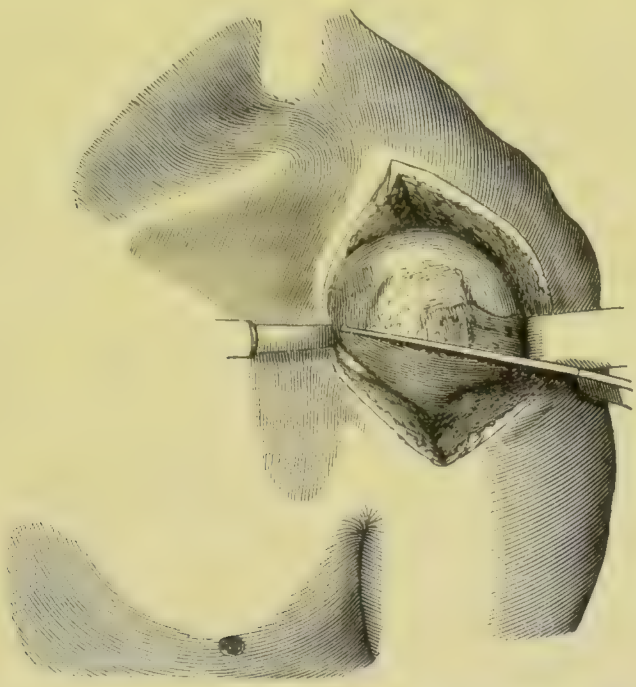
* J. Péan, *De la Scapulalgie, et de la Résection scapulo-humérale* (Paris, 1860).

FIG. 44.



SITE OF SECTION.—It being most important to leave the humerus as long as possible, not an atom more than is needful should be removed. The section should be made just below the articular surface in every case where this will remove the whole of the disease, and where all the head must go. The advantages of sawing here over division through the surgical neck are—(1) A longer humerus is left to be brought against the glenoid cavity, and aid, as a fulcrum, the action of the deltoid in elevating the arm. (2) The section is made within the capsule, after, of course, freely opening this, but not damaging its attachments to the neck of the bone. (3) The tendons in the bicipital groove are less likely to be interfered with.

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* It must not be forgotten that these soft parts are largely made up of important nerve cords. I have seen this operation followed by tetanus in a case in which the surgeon was obliged to rely on most inadequate instruments.

† In one of M. Ollier's cases, as the head of the humerus was being thrust out through the wound, the bone, which was very fragile, was broken across just above the condyles. This accident ultimately exercised no untoward influence on the result.

Mr. Davies-Colley (*Guy's Hosp. Repts.*, 3rd series, vol. xx. p. 525) relates a case of partial resection followed by unimpaired movement of the joint. As at the time of the operation a portion of the head of the humerus seemed healthy, and the disease consisted chiefly of a carious erosion of the great tuberosity and the adjacent portion of the articular surface, these portions only were removed, without dislocating the head of the bone. The part removed was chiefly the articular surface above the greater tuberosity, together with what remained of that process. The lesser tuberosity appears not to have been touched. About three-fifths of the articular surface was left, being healthy. There was some erosion of the bone below the epiphysial line, but the greater part of the disease was situated in the epiphysis. The section of the bone was hard. Seven months later the movement of the joint was "perfect in every direction. He swings the arm round above his head, and rotates it, and performs every action with as great freedom and rapidity as with the left shoulder-joint."

If the disease extends lower down, gouging may be resorted to, or, if needful, one or two further sections* may be made till healthy tissue is reached, but, as in the case of the elbow, periosteal deposits or roughenings, which will subside when the irritation is removed, must not be mistaken for disease which calls for extirpation.

The glenoid cavity is then examined, and gouged if carious. Cases where its complete removal is called for must be most rare. If really called for, it may be effected by an osteotome, or by cutting bone-forceps; but taking away the glenoid cavity must interfere with the attachments of the biceps and triceps, and cause risk by the opening up of additional cancellous tissue.

Any vessels which require it are then secured—*e.g.*, branches of the posterior circumflex artery. Sinuses are then examined, pulpy tissue scraped out with sharp spoons, drainage provided, and the upper part of the wound closed. It is well, in inserting the drainage-tube, to make a counter-puncture at the back of the upper arm, so that the site of the operation may be well drained while the patient is recumbent.

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* In cases of gunshot injury, splinters of head or shaft will have to be carefully removed, and the point determined whether the shaft is extensively split towards the elbow. This is often very difficult to determine, because a longitudinally fractured shaft may be maintained in an apparently unfractured condition by the close apposition of the fragments, and by the periosteum, &c.

The patient for the first few days should have his shoulder supported on a pillow, and wear a large pad, 5 to 6 inches thick at its base, in his axilla. By the end of the first week he should be sitting up, still wearing the pad, and after a fortnight, earlier if possible, passive movement should be begun. The fingers and elbow should be gently moved from the very first. Electricity, shampooing, encouraging the patient (if in a hospital) to sweep with a short brush, carry weights, constantly practise lifting the arm—anything, in short, which practises the patient in using the arm and new joint—should be perseveringly made use of.

Question of Sub-periosteal Resection.—As one of the chief drawbacks of the operation is the poor amount of abduction and elevation which remains, owing, in large measure, to the humerus being too short to be brought into the glenoid cavity when the deltoid acts, I think that in this joint a trial of the sub-periosteal method should be carefully made, to insure as much reproduction of bone as possible. Mr. Holmes (*System of Surgery*, vol. iii. p. 741), it is true, does not have a high opinion of this method. "I do not find any clear proof, in the recorded experience of operators who practise sub-periosteal excision, that more extensive movement is obtained after that than after the ordinary method. Nor does it seem probable that it should be so. The power to elevate the arm above the horizontal line depends on the rotation of the scapula, which carries with it the humerus, the two bones being for the moment consolidated in consequence of their perfect apposition in the joint. When the joint is destroyed, and a ligamentous connection between two irregular bony surfaces has been substituted for it, such a consolidation is impossible, and the rotation of the scapula will no longer elevate the humerus. Unless we could believe that the globular head of the humerus were reproduced, we could not expect that the power of elevation would be regained. M. Ollier speaks as if this reproduction were the normal result of sub-periosteal resection, but he refers to no dissection." Urging, as I would very strongly, the importance of giving the sub-periosteal method a full trial in this excision, I would point out that M. Péan (*loc. supra cit.*, p. 51 *et seq.*) quotes Textor as finding, eleven years after an excision of the shoulder, "a new fibrous capsule. This, hard and, as it were, fibro-cartilaginous, surrounded, by its inner surface, the upper fourth of the humerus, and embraced it so firmly as to be separated with difficulty; by its outer face it was blended, by the intervention of fibrous tissue, with the structures surrounding the joint, and particularly with the deep surface of the deltoid and the cicatrix in the soft parts." Allusion has already (p. 58) been made to the completeness of the capsule which may be met with after excision elsewhere. V. Langenbeck (*Arch. f. klin. Chir.*, 1874, vol. xvi.) gives more than one case in which the arm could be raised vertically, and the movements were excellent. While it is true that these were cases of resection for gunshot injury, and therefore the patients probably healthy adults; on the other hand, preservation of the periosteum is not likely to be so easily effected here as in those cases where it is softened by disease. Even if the periosteum cannot be completely preserved, an additional ½ inch or inch in length gained, an irregular knob or nodule-like mass which may be moulded into a rudimentary head within the new capsule, may make much difference in the future mobility and usefulness of the limb.

The following are the chief steps of the sub-periosteal method (Farabeuf):—The arm being in the position given at p. 129, and the deltoid divided, the position of the bicipital groove is made out where it lies between the tuberosities, and an incision is made a little outside the groove through the capsule and the periosteum of the great tuberosity as far down as the intended bone-section. With a periosteal elevator the lips of the capsulo-periosteal wound are then peeled off as far as the external and internal tuberosities respectively. The left thumb or a retractor keeps the soft parts back. The biceps tendon should lie safe in the inner lip of the wound. The head of the humerus should only be dislocated sufficiently to expose the level at which it is intended to apply the saw. If ankylosis is present in a shoulder it is proposed to excise, and too firm to break down, the bone should be separated by a chisel and mallet.*

AMOUNT OF BONE THAT MAY BE REMOVED.—This will mainly depend upon the amount of damage done to the periosteum, the possibility of retaining it entire, the age of the patient. Dr. Maclaren (*Lancet*, June 7, 1873) removed the head and 3½ inches of the upper end of the humerus with an excellent result.

Langenbeck mentions a case in which the whole shaft of the humerus necrosed, and was removed, the elbow-joint being resected at the same time, and yet the reproduction of bone was so complete that the shortening was no more than $1\frac{3}{5}$ inch. The patient was young, and growth went on, though the bone remained behind its fellow. The new humerus broke several times, but the movements of the shoulder and elbow were very satisfactory, and the hand was capable of most delicate movements.

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* See also Ollier, *Traité de la Régéneration des Os, et des Résections des grandes Articulations*, 1867.

Prof. Billroth (*Wien. Med. Blätt.*, March 20, 1884; *Lond. Med. Rev.*, 1884, p. 197) gives the case of a patient, aged twenty, in whom the whole of the right humerus was removed when he was twelve. Though the periosteum was carefully left intact, the bone did not form again. Yet the forearm was well developed, and, by means of an ingenious splint and an artificial shoulder-joint, the patient could use his arm and hand well. *Cf.* the remarks on excision in continuity of the shaft of the humerus.

Excision of Shoulder in Military Surgery.—The following points of practical importance are taken mainly from the *Med. and Surg. History of the War of the Rebellion*, pt. ii. p. 519 *et seq.* Dr. Otis here draws conclusions from the histories of 885 cases, 670 being for direct injury, and 215 for fractures in near proximity to the joint or for consecutive caries or necrosis.

Excision of the head of the humerus, together with portions of the clavicle and scapula—*e.g.*, acromion, spine, coracoid process, glenoid cavity—was performed in forty-two cases. It is remarkable that the mortality is less in this group than in that of simple removal. The following remarks are quoted from Lœffler:—Fracture of the glenoid cavity is especially frequent in shot injuries of the shoulder. This complication makes the prognosis of excision more serious, but is not a contra-indication. If only fissures are present, the glenoid cavity should not be removed. Tedious burrowing of pus is very likely in these cases.

Partial excision of the head of the humerus was done in fourteen cases. "The results do not prove that, when the head of the humerus is grooved or grazed by a ball, it is safer to slice off the injured part rather than to decapitate the bone. Ankylosis was too frequent to permit much to be said in favour of partial excision in this region."

Date of excision of shoulder. The *primary* cases were 273, the *intermediate* 55 in number, the results being far less satisfactory than in the primary, "and corroborating the general rule forbidding operations during the inflammatory stage after injury, except under circumstances of exceptional urgency." The mortality was twice as great as in the primary, and nearly 12 per cent. greater than in the following. *Secondary*, twenty-six cases, with a mortality of 50 per cent. The greater success of primary excision can well be understood. The condition of the soft parts is much more favourable. There is no infiltration or burrowing of pus, no softening of parts or degeneration of muscles, no caries or ostitis—none, in fact, of those complications which, in secondary excision, imperil the life and usefulness of the limb of the patient.*

Excisions of the head and portions of the shaft of the humerus as well, 293 cases, in 190 of which the precise length of bone excised was specified. Thus, in twenty-three, 4 inches; in eleven, 4½; in seven, 5; in two, 5½; and in five, 7 or 8 inches were excised. While the arm was shortened (there being very rarely any restoration of bone) and feeble, the forearm and hand were usually most useful. Where the arm was flexile and uncontrollable, an auxiliary apparatus, such as the ingenious ones of Dr. Hudson,† brought about usually a great improvement. Dr. Otis (*loc. supra cit.*, p. 611) states of shot-injury resections:—"In the majority of cases that I have examined, motion in flexion, extension, and adduction was tolerably well preserved. I have met with no instance of true ankylosis. In a large proportion of the cases, the functions of the forearm and hand were but slightly, and in many not at all, impaired. Those who argue that the limb is useless after an excision at the shoulder because it dangles by the side, display a superficial appreciation of the considerations to be taken into account. Apart from the inestimable value of even a partial use of the hand, the mere weight of the limb, though its motor functions be completely destroyed, is of advantage in preserving the equilibrium of the body and avoiding the distressing deformity consequent on ablation."

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* Dr. Otis quotes Rupprecht, one of the German authorities in the war of 1871, to the same effect:—"The secondary operations were very much aggravated by deformities, gradually appearing after the injury, through thickening of the periosteum especially, and by extensive cavities succeeding abscesses. Immediately after the operation even, healing was retarded by pus-formations, sometimes under the clavicle, in other instances under the scapula, again on the anterior aspect of the arm. Aside from the greater muscular atrophy due to debility resulting from antecedent, tedious suppurations, and to pain and loss of sleep; apart, also, from the abundant granulations attending secondary operations, and resulting prejudicially in regard to the future usefulness of the limb, the disadvantages of secondary operations already adduced were of sufficient importance to permit us to declare that primary resection of the shoulder-joint is preferable to the secondary operation."

† *Loc. supra cit.*, Figs. 449, 453.

CHAPTER VII.

REMOVAL OF THE SCAPULA.

Indications.

1. New growths. 2. Necrosis. 3. Accidents—*e.g.*, railway and machinery accidents.

As it is the first of the above which chiefly raise the question of removal of the bone, and which present the greatest difficulties, it is to removal of the scapula for new growths that most of the following remarks will apply.

Partial Removal of the Scapula.—In a very few cases (*e.g.*, for a simple exostosis, or where the surgeon is certain that he is dealing with an unmixed enchondroma in an early stage) a more limited operation may be sufficient. The chief essential points here are—(1) to freely expose the growth by appropriate flaps, so that the limits may be clearly defined; (2) to be provided with reliable instruments of keen temper, owing to the exceeding hardness which may be met with here.

While some Continental writers* have given elaborate directions for partial removal of the scapula, it is only in the above very few cases that this operation is likely to be used by English surgeons. Mr. Pollock, in his paper† on two cases of removal of the scapula, thus advises on this matter: "If a portion of the scapula be removed, it should only be the lower portion. But even if this be attempted, the loss of blood would probably be much greater than if the whole bone were removed; for the wound is more confined, and the wounded arteries are more apt to retract behind the bone above, and offer great obstacles to their being secured. However, should the lower angle be alone the seat of disease, the attempt to remove the lower portion only is justifiable. It must, however, be borne in mind that, when a bone is once the seat of disease which requires removal, the disease is very apt to recur in the portion left, and less liable to do so if the whole bone be removed.

The above remarks of Mr. Pollock are entirely borne out by the histories of cases which have been watched after partial removal of the scapula for any growth save an exostosis.

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* *E.g.*, M. A. Demandre, *Des Tumeurs de l'Omoplate* (Paris, 1873).

† *St. George's Hosp. Reports*, vol. iv. p. 236.

Thus, in January 1865 Sir W. Fergusson* removed the lower two thirds of the scapula for a sarcomatous growth. Recurrence took place, and, in the following November, the rest of the scapula, the greater part of the clavicle, and the upper extremity were taken away.

Dr. Bird, of Stockport,† removed the lower two thirds of the scapula for a growth the size of an orange in the infra-spinous fossa, in a child aged ten, the bone being sawn through behind the neck in a line with the supra-scapular notch. A year and a half later the growth recurred and grew quickly, the rest of the scapula being now taken away together with the head of the humerus, which had become adherent to the scapula, and thus also required removal. A year and a half later the child remained well, the use of the hand "in sewing and writing being very little impaired."

In the case of sarcomata, removal of the scapula alone or together with the upper extremity may be called for.

The malignancy of these growths is well known, together with their tendency to involve surrounding parts and to creep into regions inaccessible to the surgeon. Early operation is imperatively required.

In the case of operation, the prognosis will be best, however large the growth, when the rate of progress has been slow, when the growth is uniformly hard, or if only a certain amount of elasticity is combined with the hardness (as in unmixed enchondromata), when the outline is distinct and well defined, and the mass movable upon the ribs.‡

On the other hand, the prognosis is less favourable when the outline is uniform rather than nodulated or bossed, the feel semi-elastic instead of hard, the progress rapid and painful, the different parts of the scapula much obscured§ and its mobility much impaired, the outline of the growth ill defined and lost indistinctly in the axilla. Pulsation, bruit, enlarged glands, and infiltration of the skin are also of evil omen.

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* *Lancet*, 1865, vol. ii. p. 591. † *Ibid.*, p. 696.

‡ That this mobility is a matter of some importance is shown by the following case, quoted by M. Sédillot at p. 550 of his *Traité de Médecine opératoire:* "Nous refusâmes un jour d'opérer un jeune homme atteint d'un cancer énorme du scapulum, dont les limites n'étaient pas nettement fixées, et nous dûmes nous applaudir de notre abstention en découvrant plus tard, à la nécropsie, que la tumeur avait pénétré dans la poitrine et envahi un lobe pulmonaire."

§ In a very large scapular sarcoma on which Mr. Pollock operated, it is stated that "the mass extended over the upper portion of the scapula, which could not here be traced, and over the outer part of the clavicle, which could not be felt; and also so far into the lower triangle of the neck that the subclavian artery could

A. **Removal of the Entire Scapula by itself** (*e.g.*, cases where the growth is primary from the scapula, and where there is no extension to the humerus or into the axilla).—Preparations against shock should be taken, the extremities being bandaged in cotton-wool, the head kept low, ether given, and subcutaneous injections of ether and brandy being in readiness. The patient is placed at the edge of the table and rolled over to the opposite side. If the growth is very vascular, the patient weakly, pressure on the subclavian is of importance, or if, from the extension of the growth, it is rendered difficult, this may be effected by making an incision down to and through the deep fascia over the artery itself, in order to enable an assistant to put the thumb or finger directly upon it.* This may be done by a separate incision, or by an extension of that by which the clavicle is divided.

Flaps are freely turned back, usually by a T-shaped incision, one limb running from the acromion process inwards to the superior angle of the scapula, while the other and longer is made at right angles to the first down to the angle of the scapula. In another case the surgeon may prefer to make an incision along the vertebral border of the scapula, and the other at right angles to it across the centre of the growth.† Flaps thus shaped are dissected quickly back, care being taken not to open the capsule of the tumour.‡

When the whole mass is thoroughly exposed, the muscles on the vertebral border are first severed. The subclavian being now firmly compressed, the trapezius, levator anguli, and the rhomboidei are cut through,§ the posterior scapular artery secured, and the

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not be distinguished or reached by the finger." The whole mass was removed, but the patient, aged forty-seven, died on the sixth day, of chronic bronchitis.

* As adopted by Prof. Syme in performing the old operation in a case of axillary aneurism, p. 105. If the clavicle is going to be removed, the subclavian can be commanded by cutting down on the clavicle, freeing it from its attachments in its inner third, passing a flat director carefully beneath it, sawing through the bone here, and removing a portion of it, the finger being thus placed directly on the subclavian (Jeaffreson, *Lancet*, 1874, vol. i. p. 759).

† If the skin is involved or ulcerated, the flaps must be so shaped as to isolate this.

‡ Pollock, *St. George's Hosp. Reports*, vol. iv. p. 237.

§ It is a bad sign if any of the muscles severed are infiltrated with growth. That this, however, is not incompatible with a good recovery is shown by the second of Prof. Syme's cases (*Excision of the Scapula*, p. 28), in which it is stated that "the tumour weighed between 4 and 5 pounds; it had a soft conserratus magnus divided, being first made tense by lifting the scapula off the ribs upwards and outwards. The muscles on the upper border are next* attacked—viz., the deltoid, the omo-hyoid, and the supra-spinatus—and the supra-scapular artery secured. The acromio-clavicular joint is next opened, or else the acromion or clavicle,† according to the extension of the growth in this direction, severed by bone-forceps or a narrow saw. If the acromion can be safely left, the resulting deformity—viz., dropping of the shoulder and entire loss of trapezius action—will be lessened.

The lower angle and the latissimus dorsi (if involved) being freed, the scapula can now be dragged away from the chest by slipping two or three fingers over the upper or vertebral border. Thus, by tilting the scapula outwards, the axillary border can be inspected, the teres and infra-spinatus muscles severed, the position of the sub-scapular artery defined by a finger passed beneath it, and this vessel secured, if possible, before it is cut. The scapula being still farther pulled away from the chest, the muscles attached to the coracoid process are next severed, and the scapula removed by cutting into the shoulder-joint and severing the capsular tendons and the biceps and triceps. The coracoid process may become detached at this stage if partially eroded by extension of growth.‡ If this happen, it must be carefully dissected out afterwards.§ Every vessel must be thoroughly secured when it is

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sistence and very suspicious aspect, which was strengthened by microscopical examination, as the muscular substance that was taken away along with the growth appeared to be loaded with the germs of future disease; but fifteen months having elapsed since the operation was performed, without the slightest appearance of relapse, it may be hoped that the recovery will prove permanent."

* If the upper border can be taken before the axillary one is dealt with, the subclavian can be better controlled when the sub-scapular artery (a source of free hæmorrhage) is severed.

† Prof. Spence (*Ed. Med. Journ.*, August 1872, p. 178) recommends that the clavicle should be left, not sawn through, otherwise the head of the humerus tends to project through the incision, there being nothing but skin left, the overhanging arch of bone having been removed. On the other hand, sawing the clavicle, while it leaves a cut surface of bone as a possible source of irritation, facilitates the operation somewhat, as it exposes better the large vessels and the muscles attached to the coracoid process.

‡ Especially if the patient be a young one, as in a case of Mr. Pollock's.

§ If the growth has involved the axillary vessels and nerves, this outlying portion may be dealt with later on, after the main mass has been separated and removed. If it is desired to remove this extension of the disease now while in continuity with the scapular growth itself, the surgeon will have both his hands free for what is a troublesome dissection, by asking an assistant to drag the main mass strongly backwards. To facilitate this step, Prof. Syme (*loc. supra cit.* p. 26) placed a piece of cord round the divided extremity of the clavicle, for the assistant to pull upon. The greatest care must be taken, when dealing with prosevered; otherwise, oozing is very likely to take place a few hours later.* If the anastomoses are free, double ligatures will be required.

Hæmorrhage may be best avoided by attention to the following points:—(1) Adequate pressure on the subclavian, this being effected by a special incision, if needful, to command the vessel. (2) Taking care not to cut into the tumour itself. (3) Dealing with the axillary border and sub-scapular artery last. (4) By some it is recommended to make the incisions gradually, not larger than are required at the time, as a means of minimizing the hæmorrhage. It must be remembered, with regard to this point, that small and cramped incisions interfere with a free and rapid hand and sufficient exposure of the parts, conditions which conduce to thorough dealing with bleeding points, and thus facing one of the chief difficulties of this important operation.

Adequate drainage is now provided, the flaps united, and the arm secured to the side for a few days, after which it may be supported in a sling if the head of the humerus does not tend to protrude.

CONDITION OF THE LIMB AFTER REMOVAL OF THE SCAPULA.—A limb thus preserved will be strong and useful. If the clavicle has not been much interfered with, the clavicular fibres of the deltoid will remain, and these, together with the latissimus dorsi and pectoralis major will probably confer a fair amount of motion on the limb. In one of Prof. Syme's cases, after removal of the scapula and the outer third of the clavicle, and, by a previous operation, the head of the humerus, the patient was able to lift heavy weights, and to fill the appointment of provincial letter-carrier.

In a very successful case of Mr. Symonds' (*Clin. Soc. Trans.*, vol. xx. p. 24), in which the scapula was removed for osteo-sarcoma, the man was in good health two years and a half after the operation. "He was able to do all the lighter work of a carpenter, including the use of a plane. Overhead work he could not do." In this case the articular surface of the humerus had also been removed about a month later, as it was thought to be the cause of prolonged suppuration.

B. **Removal of the Scapula, together with the Upper**

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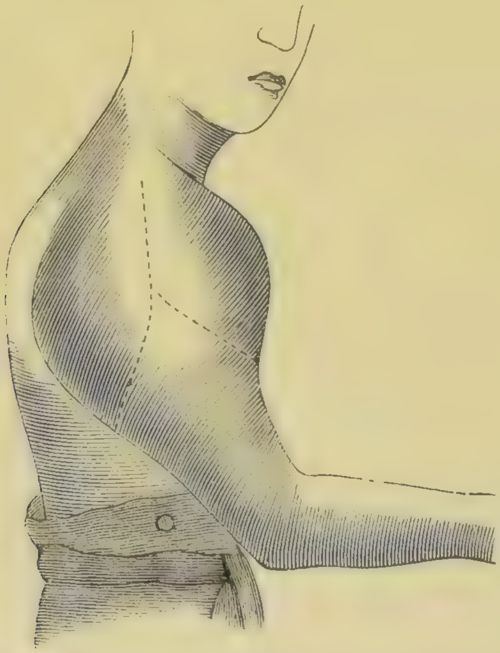
jections into the axilla, to keep the knife, or blunt dissector, very close to the growth, for fear of opening the large vessels.

* In a case of this kind, Mr. Berkeley Hill transfused twice, but unsuccessfully, the patient dying of shock and acute septicæmia, in forty-five hours (*Brit. Med. Journ.*, 1880, vol. i. p. 487).

Extremity (Fig. 45).—This operation is required in cases where a growth has involved the axilla and humerus as well as the scapula, and in a few cases of machinery accidents. In the former case it may be performed on the following lines, modified to suit the case (Fig. 45).

The patient being prepared and placed as directed at p. 139, the surgeon commences his incision over the outer third of the clavicle, and thus can now either proceed to secure the subclavian artery at once, or enable an assistant to put his finger directly upon the vessel. In the former case the soft parts must be separated with a raspatory, the subclavius divided, and the vessels found beneath it. From the end of this incision, over the acromio-clavicular joint, another is made curving outwards over the shoulder and upper part of the arm, and then sweeping back to the inferior angle of the scapula. This curved, oval flap is then raised towards the spine, the muscles on the vertebral and upper borders of the scapula divided, and the posterior and supra-scapular vessels secured. The scapula, with the arm, is next carried bodily forwards towards the axilla,† and the sub-scapular

Fig. 45.*



(After Heath.)

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* This drawing is based upon one of a patient of Mr. Heath's (*Brit. Med. Journ.*, 1886, vol. i. p. 66). The outline of the flaps has here been brought somewhat too low down upon the arm.

† During these or other necessary manipulations, the humerus, if much invaded by growth, may give way.

vessels secured and divided, together with the muscles in the axillary border. A second incision, the extremities of which meet the first, is then made over the front of the shoulder and arm, curving back across the axilla. When the anterior flap, thus marked out, has been sufficiently dissected up, the large vessels, if not already dealt with, are found and secured before their division, and the limb and scapula removed.

All hæmorrhage being securely arrested, the flaps are next submitted to careful scrutiny for any suspicious infiltration, and the axilla examined for any enlarged glands or outlying masses of growth. Careful irrigation with lot. hyd. per. 1 in 2000 should be employed, due drainage being also provided.

AGE OF THE PATIENT.—It may be not uninteresting to some to know that the scapula has been successfully removed for growth at ages varying between "about seventy" and "about eight." The former was a patient of Prof. Syme,* who died about two months after the operation, apparently of internal deposits. The latter case occurred in India,† the upper extremity being removed at the same time.

Dangers of the Operation and Causes of Death.—These are chiefly—

(1) Hæmorrhage. (2) Shock. (3) Septicæmia.

(4) Entrance of air into veins. This very nearly proved fatal in a case in which Mr. Jessop, some years ago, removed the scapula, outer half of the clavicle, and the upper extremity (*Brit. Med. Journ.*, 1874, vol. i. p. 12). In this case the scapula seems to have been removed owing "to considerable deficiency of cover" after removal of an upper limb much damaged by a machinery accident. "Whilst cutting through the last attachments of the scapula, two distinct loud whiffs were heard, caused by the rush of air into the subclavian vein." The operation was completed while artificial respiration was being performed, and the lad recovered.

5. Recurrence. This takes place, usually, within six or twelve months. In a case of Mr. Heath's (*loc. supra cit.*), recurrence took place seven months after extirpation of arm and scapula in a lad aged sixteen, with two years' history of the growth, an "osteo-sarcoma." The recurrent growth was removed, but two years and a half after the original operation recurrence again took place,

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* *Loc. supra cit.*

† A very brief mention of this case is given in a letter, *Lancet*, 1874, vol. i. p. 819. It is not stated whether the patient was a native or no.

and was dealt with about five months later. A rapid recovery took place, and at the time of this, the latest operation, no signs of extension to the internal organs could be detected, and the patient was in robust health.

*Removal of the scapula for caries** needs no especial mention. The parts being sufficiently exposed, the operation will be conducted, as far as possible, sub-periosteally, by means of appropriate blunt dissectors or periosteal elevators.

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* A good case of this kind is recorded by Sir W. Fergusson (*Med.-Chir. Trans.*, vol. xxxi. p. 310). An exquisite drawing of the scapula—one of the very best by the hands of the Baggs—will be found in the same author's *Practical Surgery*, 4th ed. p. 309, Fig. 144.

CHAPTER VIII.

OPERATIONS ON THE CLAVICLE.

REMOVAL OF THE CLAVICLE.

Removal may be required for new growths or necrosis. In either case it is very rarely called for. That for necrosis differs in no way, save for the importance of surrounding parts, from the same operation elsewhere.

Removal of Clavicle for New Growths.—No better idea of the kind of operation required, and the difficulties likely to be encountered, can be gained than from the account of Prof. Mott's celebrated case.*

A youth, aged nineteen, consulted Prof. Mott in 1828 for a tumour about 4 inches in diameter, very hard, firmly attached to the clavicle, which had been noticed about four months, and which was fungating owing to irritation by escharotics, &c.

An incision, begun over the sterno-clavicular joint, was carried, in a semicircular direction, as close to the fungating part as was safe, to near the acromio-clavicular joint. In dividing the pectoralis major, arteries sprang in every direction; a number of large venous branches, under the muscle, also required ligature. Care was taken to avoid the cephalic vein, which was drawn outwards. Finding it impossible, from the size of the tumour and its close proximity to the coracoid process, to get under the clavicle in this direction, an incision was made from the outer edge of the external jugular, over the tumour, to the top of the shoulder. After dividing the skin, platysma, and part of the trapezius, a sound part of the clavicle was exposed nearer to the acromion than the coracoid process. A steel director, very much curved, was now cautiously passed under the bone from above, great care being taken to keep the instrument in close contact with the bone. The great depth of the clavicle from the surface rendered it somewhat difficult to accomplish this safely; an eyed probe, similarly curved, conveyed along the groove of the director a chain saw, which, when moved, showed that nothing intervened between it and the bone; the clavicle was then readily sawn through.

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* *Amer. Journ. Med. Sci.* (O.S.), vol. iii. p. 100.

The first rib being next exposed under the sternal end of the clavicle, below the pectoralis major, the rhomboid ligament was divided and the joint opened. This gave great and encouraging mobility to the diseased mass.

The sawn end of the clavicle being a little elevated and the parts around it loosened, the surgeon tried to discover the subclavius muscle, but it could not be seen, being incorporated with the diseased mass. Had this muscle been found, the separation of the tumour would have been much less difficult and tedious, as, by keeping above it, the subclavian vein is, of course, protected. The origin of this muscle was seen and divided, but it was almost immediately afterwards obliterated in the tumour.

The omo-hyoid was found under the sterno-mastoid, and traced to its origin on the scapula. In separating the tumour from the cellular and fatty tissue between the omo-hyoid and the subclavian vessels, a number of large arteries were divided, which bled freely, particularly a large branch from the inferior thyroid.

The anterior part of the upper incision was now made from the sternal end of the clavicle, and carried over the tumour, until it met the other at the external jugular vein. This vein was then cut between two fine ligatures.

The clavicular part of the sterno-mastoid was next cut about 3 inches above the clavicle, and the anterior scalene exposed by careful dissection.

The subclavian vein from the edge of the scalenus to the coracoid process was so firmly adherent to the tumour as to lead the operator at one moment to believe that the coats of the vein were so intimately involved in the diseased structure as to render complete removal utterly impracticable. By the most cautious proceeding, however, alternately with the handle and blade of the knife, he finally succeeded in detaching the tumour without the least injury to the vein. This part of the operation was attended with peculiar difficulty and danger. At every cut an artery or vein would spring and deluge the parts until secured by ligatures. The external jugular was so situated in the midst of the bony mass as to require division again here between two more ligatures near to the subclavian. Near the sternal end of the clavicle, a large artery and vein required ligature; they were considere branches of the inferior thyroid.

From having cut through the clavicular portion of the sterno mastoid, it was possible, by turning the tumour down, to detach it from the situation of the internal jugular and left subclavian without the least injury to these important parts.

To reach the lower part of the tumour as it extended upon the thorax, it was necessary to separate the pectoralis major in a line with the fourth rib. The incision upon the neck extended from the sterno-clavicular joint, in a semicircular direction, to within 1 inch of the thyroid cartilage and base of the lower jaw, and 2 inches from the lobe of the ear, and terminated near the acromio-clavicular joint.

The discharge of blood was so free at every step of the operation that about forty ligatures were applied. It was estimated that the patient lost from 16 to 20 ounces of blood. Prof. Mott stated that the operation far surpassed in tediousness, difficulty, and danger anything which he had ever witnessed or performed.

The tumour was an osteo-sarcoma, about the size of two adult fists.

The patient made a good recovery, and died fifty-four years after the operation, from causes unconnected with this disease. The use of the arm is said to have been complete. Post-mortem examination showed that $\frac{3}{4}$ inch of the acromial end of the clavicle was left, the rest of the bone being occupied by an adventitious ligamentous band.*

Strict observance of antiseptic details is especially needed in such operations, owing to the great risk of diffuse cellulitis in this region.

Mr. Wheeler, of Dublin, records† a case of complete removal of the clavicle for osteo-sarcoma. The patient was forty-three, and the growth extended all over the clavicle, save at the extreme ends.

A curved incision was made downwards from the sternal to the acromial extremity of the clavicle. The sterno-mastoid and other muscles being divided, the acromio-clavicular joint was opened and the clavicle dragged up with lion-forceps. The coraco-clavicular and other ligaments were then divided, and the subclavius detached. The subclavian vessels were exposed, and, with the thoracic duct (the operation was on the left side), carefully avoided. A vertical incision was required upwards into the posterior triangle. Fourteen ligatures were needed.

The patient made a good recovery, and when seen, ten years later, had, to an ordinary observer, every power as if the clavicle had not been touched.

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* *Amer. Journ. Med. Sci.*, vol. lxxxv. p. 546.

† *Dub. Journ. Med. Sci.*, May 1, 1885.

Mr. Holmes[*] draws attention to the fact that one case is on record in which Mussey,[†] of Cincinnati, removed the whole clavicle and scapula for a tumour recurring after amputation at the shoulder-joint. The patient was heard of in perfect health thirty-four years afterwards, at the age of seventy-one. Mussey commenced from the inner side, so as to tie the subclavian early in the operation ; and this would probably be the best course if the state of the parts would allow of it. Mr. Holmes followed the same course in a similar case. The patient recovered rapidly, but died from a recurrence. Mussey nearly lost his patient from the passage of air into the subclavian vein.

UNUNITED FRACTURE OF THE CLAVICLE.

While this condition is extremely rare, it is of such importance as to claim some notice here.

An excellent instance, most successfully treated, has been recorded by Mr. Barker.[‡] A boy, aged twelve, was noticed soon after birth to have a fracture of the right clavicle, the cause of this being uncertain. Up to nine years of age the child had no inconvenience. He was then gradually more and more troubled with pressure on the brachial plexus, pain down the arm, and a tendency of the fingers to become stiff and fixed in a flexed position in writing, this condition soon amounting to one of painful spasm, rendering the writing quite illegible.

With a view of resecting the false joint, lifting the inner end of the outer fragment off the brachial plexus, and wiring it to the inner fragment, Mr. Barker operated as follows :—

" Observing all the details of the Listerian method of antisepsis, I made a semilunar incision, about 3 inches long, with its two ends on the clavicle, and its convexity downwards. This corresponded to the middle of the bone, having the false joint above its centre. The flap of skin so formed was turned upwards off the bone, and with it I dissected up some fibres of the pectoralis with the object of securing that the nutrition of the skin should not be disturbed by dividing its deeper vessels. The bone being thus exposed, a false joint was found between the broken ends, which were united by fibrous tissue. I now divided the outer end of the inner fragment obliquely in a plane running from within outwards, and from before backwards. The section was made with Gowan's osteotome, and was done very cautiously, so as to disturb the periosteum and soft parts as little as possible, and obviate all risks to the vessels running beneath the clavicle. I then placed the osteotome on the inner end of the outer fragment, and divided it in a plane corresponding to that of the section of the inner fragment. Here my first cut was too oblique, and I withdrew the blade of the saw; but the second was accurately placed and sacrificed less bone. I now lifted the inner end of the outer fragment off the brachial plexus, and placed its cut surface resting upon that of the inner portion of the bone. A silver wire was then passed through both ends from before backwards, and twisted firmly. This seemed to secure sufficient fixation of the two portions, and the ends of the wire were cut, and the twisted portion bent level with the bone. The skin was then united with ordinary carbolized catgut, the edges of the pectoral muscle having been first brought together with stitches of the same. A strand of catgut was also inserted between the lips of the wound for drainage. No blood to any amount was lost, and the wound was a dry one. I therefore dressed it with powdered iodoform and salicylic wool, considering the latter more elastic than gauze. Plenty of ordinary wool was added for padding, and over all a plaster-of-Paris bandage was laid on. This was applied over a webbed vest precisely as for spinal caries, and completely immobilized the arm and shoulder for the month during which it was worn. To this perfect fixation of the parts concerned, quite as much as to the accurate apposition of the cut surfaces of the bone, the good result of the operation is, in my opinion, to be ascribed."

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[*] *System of Surgery*, vol. iii. p. 743.

[†] *Amer. Journ. Med. Sci.*, vol. xxi.

[‡] *Clin. Soc. Trans.*, vol. xix. p. 104.

The dressings were not disturbed for fourteen days, when the wound was found united by first intention, except at one point where the catgut drain was still unabsorbed. There was not a drop of pus anywhere. A similar dressing was applied, and not removed for fourteen days, when all healing was complete. The plaster corset was then removed, and a mass of callus could be felt at the seat of operation. A week later the power of writing was found to be much improved, and the arm became perfect in all its functions.*

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* Mr. Pollard (*Brit. Med. Journ.*, 1887, vol. i. p. 676) records a case of ununited fracture of about four months' duration in an infant aged eighteen months, in which he resected and wired the fragments with an excellent result. Sound union followed, and the arm, previously hardly used at all, was moved as well as the other.

In those cases where much deformity has followed union of a fractured clavicle, it will be quite justifiable, with strict antiseptic precautions, to explore and remove the projecting bone, with an osteotome or saw. I have done this in a young woman in whom a very ugly projection remained after the union of a fracture some years before. The wound healed in eight days, and not only was the deformity removed, but the pain in the hand and weakness of the limb (no doubt very largely neurotic) disappeared entirely after this operation, which was performed at the patient's urgent request. I think such steps may well be taken more frequently. The subclavius renders the important parts below the clavicle quite safe.

PART II.

THE HEAD AND NECK.

CHAPTER I.

OPERATIONS ON THE SCALP.

BUT few—viz., those for large fibro-cellular tumours, and the vascular tumours known as aneurisms by anastomosis, &c.—will require mention in a work like this.

FIBRO-CELLULAR TUMOURS, OR MOLLUSCUM FIBROSUM.

These rare growths occasionally require removal, on account of their hideous deformity.[*] The chief points of importance in such operations are—(1) The hæmorrhage. This may be terrific,[†] copious, and weeping from every part, owing to the huge size of the growth and the vascularity of the parts. It is best met by an ingenious precaution of Mr. Hutchinson's,[‡] who prevented all arterial hæmorrhage during an extensive operation of this kind by applying round the head, just above the ears, a Petit's tourniquet with a narrow strap. In a smaller case, strong india-rubber bands, with pads over the chief arteries, may perhaps be useful. (2) The need of maintaining strict asepsis. As nearly the whole thickness of the scalp affected must usually be sacrificed, the pericranium may be damaged and the bone necessarily exposed, especially during the tedious process of granulation by which the extensive wound must usually heal. The risk of septic ostitis and then phlebitis of the veins of the diploë is well known, with the inevitable result of pyæmia.

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[*] A good illustration of these growths is given by Mr. Hutchinson (*Lond. Hosp. Reports*, vol. ii. frontispiece), and another by Mr. Erichsen (*Surg.*, vol. ii. p. 533). The drawing in this case is said to be taken from a patient of Sir W. Stokes. This surgeon figures an excellent one (*Dub. Journ. Med. Sci.*, vol. lxi. (N.S.), frontispiece).

[†] It is so described by Sir W. Stokes (*loc. supra cit.*). The patient, a man aged thirty-three, in good condition, almost died on the table, Nélaton's method of inverting the head being made use of with excellent results.

[‡] *Loc. supra cit.*, p. 118. The piece of scalp removed here was twice as large as the palm of the hand. Owing to the precautions taken, there was no arterial hæmorrhage. In Sir W. Stokes' case, the base of the growth was very wide, reaching from above and in front of the right ear to the left of the occipital protuberance, upwards as high as the vertex, and hanging down as low as the shoulder. In such a case, Mr. Hutchinson's plan might be made use of by applying the tourniquet carefully round the lower jaw and nape of the neck if it could not be applied from the latter point obliquely upwards on to the forehead, the strap being kept low in position, if needful, by loops of bandage passed under it on either side, and drawn downwards by assistants.

ANEURISM BY ANASTOMOSIS.

The treatment of these most difficult cases is given under the head of Ligature of the External Carotid.

QUESTION OF OPERATIVE INTERFERENCE IN GROWTHS OF THE CRANIAL BONES AND DURA MATER.

Under this heading are included malignant growths, usually sarcomatous, springing from the diploë or the dura mater, and having in common the features of steady progress, penetration of the skull, and pulsation. It remains to be seen what operative attacks, aided by antiseptic surgery, may avail in these cases, but for the present, unless an opportunity arise for attacking such growths quite early—*e.g.*, while they are only of the size of a small nut—it will be wiser not to interfere.*

The following case is a good instance of these growths, though it remains uncertain as to its exact origin. The question of operation, as mentioned below, was repeatedly discussed here.

D. E., aged twenty-eight, a Welsh miner, was sent to me, in 1885,† by Dr. Evans, of the Rhondda Valley. Three years ago he had noticed a swelling, the size of a pigeon's egg, in the centre of the right parietal bone; for a year previous to this he had pains in the head. During his work in the mine, his head had received repeated blows, many bluish characteristic scars being present.

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* Further carefully recorded cases, with post-mortem records, paying especial attention to the possibility of removal, are much needed here. An interesting case is published by Mr. Morris (*Path. Soc. Trans.*, vol. xxxi. p. 259). The disease here certainly took six years in running its course; other deposits were present. The patient died away from London. The growth is stated to have begun in the diploë, and to have compressed, not involved, the brain. Mr. West (*Lancet*, 1876, vol. i. p. 457) records a case of fungus of the dura mater, which was explored. This case, however, from the history, appears to have been syphilitic; the growth was checked, and disappeared under the influence of very moderate pressure. Fits occurred later, and proved fatal. Deposits, thought to be scirrhous, were found in the liver.

† He was still alive in 1890.

A month after the lump appeared, fits began to occur nightly, and lasted thus for three months; then they gradually became fewer, and for the last year there had been none at all.

At a spot 2 inches above the left ear was a large elevation of the scalp, measuring nearly $5\frac{1}{2}$ inches in one diameter, and about $4\frac{3}{4}$ in the other. There was no ulceration of the scalp tissues here, but unusually large vessels were to be felt over the area thus prominent. In the centre the bones of the skull appeared to be deficient over a circular spot the size of a shilling, as here the scalp could be deeply dimpled by finger-pressure as if through a ring of penetrated cranial bone. Over this central gap, pulsation was strongly marked and rather heaving; it was also present, to a less degree, over the rest of the swelling.

At other parts of the area of the growth, especially at several spots in the periphery, was a remarkable feeling as if of bony, trabecular structure. It was doubtful whether this was brought about by growth invading a flat cranial bone, or to calcification taking place in the periphery of a sarcomatous growth. On a level with the left ear was an enlarged gland.

Mr. Targett, then surgical registrar, reported that double optic neuritis was present, but no oculo-motor paralysis. The reflexes were normal, and there was no loss of sensation or motion.

There were no urgent symptoms; the patient had occasional throbbing and pain in the swelling, but no obstinate headache and vomiting; he was able, as yet, to work, and stipulated that no operation involving risk to life should be performed.

For these reasons, and because, owing to the size, duration, and characters of the growth, the risk of attacking it was undoubtedly great, the patient left the hospital without anything being done.

Unless such a case can be seen very early (and this is just the stage which does not come under the notice of the surgeon), the following would appear to be amongst the difficulties and risks of an operation in these cases:—

The necessary difficulty and tediousness in isolating the affected bone by sufficient trephine crowns, and joining these with a saw or chisel.* In the above case at least four crowns must have been removed at the different angles of the growth. It must be remembered that the overlying soft parts were extremely vascular and perhaps (from the enlarged gland) already involved in the growth. In isolating and going wide of the affected bone, it was uncertain whether one or more sutures would not have to be crossed, and sinuses, such as the superior longitudinal, opened, thus leading to profuse hæmorrhage* in addition to that certain to be met with in dealing with the soft parts and with the diploë around the affected bone.

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* The use of the dental engine in these cases is alluded to elsewhere (p. 164).

Then, supposing the bone sufficiently removed, wide of the growth, in one or more pieces, if the growth were from the dura mater, this membrane must certainly be dealt with, and the same would very likely be the case if, originating in the diploë, the growth had crept inwards. In further isolating the disease, if it had merely pressed upon the brain and not involved it, most delicate work would be required: enlarged branches of the middle meningeal and, very likely, dilated sinuses would require dealing with. If the disease had involved, instead of merely displacing, the brain, new and special risks would have to be encountered just when the patient's condition, after an already prolonged operation, was least fitted to bear them.

Such are amongst the chief difficulties and dangers which appeared to me very likely, if not certain, to be met with. They do not appear to me to be exaggerated.

Moreover, in these and in any other prolonged operations which deal with the brain and its membranes, the fact must never be lost sight of that, what with the necessary interference with very vital organs, and what with the anæsthetic, the margin left to the patient between life and death may be a very narrow one.†

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* An attempted removal of a growth, afterwards proved to spring from the dura mater, is recorded by Sir W. Lawrence (*Med. Times and Gaz.*, 1853, vol. ii. p. 129). The operation was abandoned owing to the hæmorrhage. The patient died about two months later.

† About four years ago I had occasion to explore and attempt the removal of a glioma, proved later to occupy almost the entire right frontal lobe of a patient at Guy's Hospital. The pulse failed so ominously with chloroform that, after removing one crown, ether was given while the trephine was applied again, and the two openings thrown into one. The substitution of this anæsthetic was followed by so much cyanosis and jerky, gasping, irregular breathing, with a fixed chest (the patient was a young man, much emaciated by vomiting and headache, but free from any lung-trouble), that it was decided to do no more that day. The patient never "came to," and died comatose a few hours later. In this case there had not been time to interfere with the brain and its membranes. Another patient of mine, admitted for epileptic seizures connected with a huge cancellous exostosis of the frontal bone, which, as it proved, was pressing inwards upon the brain and membranes, had been under observation for a fortnight, his diet being strictly regulated. On the evening of Christmas Day, his diet having been not unnaturally, but too suddenly, altered, a severe epileptic seizure came on; this was followed by coma, rapidly deepening into death. I have elsewhere (p. 177) alluded to the suddenness with which respiration may fail in patients the subjects of middle meningeal hæmorrhage.

CHAPTER II.

TREPHINING.*

OPERATIVE INTERFERENCE† IN IMMEDIATE OR RECENT‡ FRACTURES OF THE SKULL.

Indications.—The chief of these are:

i. COMPOUND DEPRESSED FRACTURES.—Whether symptoms of compression are present or no, these fractures should, as a rule, be explored by reflecting adequate flaps, then elevating any depressed fragments, and removing any which are quite loose. At the same time the surface of the dura mater, where exposed, should be carefully scrutinized, and, together with the rest of the wound, thoroughly cleansed.

With regard to "thorough cleansing," I may draw the attention of my younger readers to the following forcible remarks of Prof. Nancrede (*loc. supra cit.*):—"Suppose a recent head injury just brought into the hospital, how should we proceed? Do not carelessly pass the forefinger through the filthy, blood-matted hair and explore at once the depths of the wound to ascertain its nature, as is too commonly the rule, but carefully shave the scalp, scrub it with a nail-brush, soap and water, remove all fatty matter with ether or turpentine and alcohol, completing the disinfection by a thorough irrigation with mercuric bichloride solution."

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* I may take this opportunity of saying, once for all, that much of what is written below is based upon a strong belief that trephining, if carried out by careful hands, and with a strict attention to antiseptics, is, *per se*, an operation of very slight risk. This opinion has been strongly held by Mr. Walsham in England, and Dr. Briggs, Pr. Nancrede, Dr. Amidon, and Dr. J. B. Roberts in America, in papers referred to below. Pr. Nancrede (*Med. News*, Jan. 28, 1888), in support of the belief that trephining is not a dangerous operation, and that more die from complications which might have been prevented by timely interference than from the removal of a disc of bone, shows that the old mortality of trephining *per se*, which he puts at 10.69, is now, with antiseptic precautions, reduced to 1.6 per cent., "although it must not be overlooked that injuries to the brain, its membranes or vessels, by careless operating, will increase this death-rate."

† This term is used to include the use of the elevator and dressing-forceps as well as that of the trephine, a matter which is alluded to again below (p. 163).

‡ By these terms it is intended to make a distinction between those cases in which operative interference is made use of within a few days of a fracture and those in which it is only had recourse to a long time after the injury: see p. 185, Trephining for Traumatic Epilepsy.

Operative interference is indicated in these cases for two reasons: (*a*) Even if no symptoms of compression are present at first, secondary inflammation is very likely to follow in a few days, it not having been possible by expectant treatment to completely cleanse the wound. If, now, some minute fragment of the brittle inner table has pricked the dura mater, fatal septic meningitis is almost certain. If, therefore, the surgeon, in these cases, waits for evidence of compression as a justification of operative interference, he will too often wait till it is too late. Evidence of the presence of dirt,* especially of dirt ground down to, or into, the bone, is a reason for exploring the wound, even if no symptoms of compression are present. (*b*) If the patient recover from the immediate effects of the fracture, injury to the inner table, insufficient to cause symptoms at the time, and not detectable save by an operation, may be present all the time and cause much future trouble. In the words of Prof. Nancrede:† "Undoubtedly, many patients recover in whom the bone is not elevated, but in too many epilepsy, insanity, chronic cerebral irritation, &c., render life a burden, and operations are then required which often prove useless.‡ . . . . Operations for epilepsy show at times that, in the effort to bridge across the irregular fragments, and from the constant irritation due to the cerebral pulsation driving the dura mater against the bony fragments, Nature throws out osteophytic growths, which eventually—perhaps after years—set up serious trouble."

ii. SIMPLE DEPRESSED FRACTURES.—Where symptoms of compression are present, operative interference is the only course open. But where no such symptoms are present, the expectant treatment is by most surgeons held to be sufficient. We may perhaps come best to a decision as to using operative interference in simple depressed fractures, without symptoms, by dividing them into the three following groups:—

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* As proving that it is not only the risk of pressure on the brain, but also the entrance of septic matter, that indicates the use of the trephine, Wagner (Volkmann's *Samml. klin. Vorträge*, pp. 271, 272)—I am indebted to Pr. Nancrede for this reference—shows that it has been proved in more than one instance that even a hair caught in a fissure will certainly produce infection if not promptly removed. The same writer puts the mortality of immediate trephining at only 1.23; that when twenty-four hours or more had elapsed, at 33.33 per cent.

† *International Encyclopædia of Surgery*, vol. v. p. 24.

‡ Dr. Gunn (*Trans. Amer. Surg. Assoc.*, vol. i. p. 89), speaking of later trephining for the relief of old depressed fractures, says: "Although results of these secondary operations do not show a flattering percentage of success, I think that the reason may be looked for in the late period at which the operation is performed. It is rare that the patient submits to the dreaded operation till years have been wasted in the vain endeavour to effect a cure by medication. In the meantime, the constant irritation has begotten a permanent impression upon the brain and nervous system, which remains after the offending point of irritation has been removed."

1. Where the depression extends over a considerable area, where it is slight in degree—*e.g.*, not more than a sixth of an inch, especially if the patient is young and the bones yielding—expectant treatment is no doubt the best.

2. But, on the other hand, where the depression is limited and defined, where the depressed fragment not only affects a small area, but is turned down angularly or edgeways, operative interference should be resorted to at once, even though no symptoms are present, and whether there is a wound or no, to prevent the onset of dangers, immediate and remote, fully alluded to later on.

3. There is a large class of cases intermediate between the above, where the fracture is a simple one, where symptoms are absent, and where the depression is sufficient to cause anxiety, though not so sharply defined as to call imperatively for operation.

Finally, in any fracture in which the question of operative interference arises, the kind of violence must be remembered. Was this concentrated over a small area, and thus likely to bring about serious depression and comminution of the internal table, or was it indirect and diffuse, and thus likely to have produced a long fissure-fracture with little depression, but perhaps tearing open meningeal vessels or sinuses, opening up the middle ear, nose, or pharynx, and spreading far into the base?

In cases of simple depressed fracture, if the surgeon decide to wait for symptoms, he can appeal to an array of great names who concur in putting aside operative interference in these cases. While it is much to be desired that, in this as in other cases where modern surgery seems likely to reverse the weighty opinion of those who have gone on before us, no change in practice shall be made hastily, it is impossible to write on this matter nowadays without seeing that, owing to the introduction of antiseptics and the lessening dread of operations on the skull and brain, the pendulum of opinion, which has for so many years swung in the direction of non-interference, is now coming back towards the opposite view.

However these questions may be decided, it will be agreed that all surgeons departing from the time-honoured rule of non-interference in simple depressed fractures without symptoms, must, by paying careful attention to the following points, make certain of not bringing disrepute on trephining or elevation of bone :—

1. That a freer use of the trephine in doubtful cases can be justified alone by keeping the wound strictly aseptic throughout.

2. Any conditions contra-indicating the operation must be carefully looked for—viz., (1) Encephalitis; (2) Injury to the base.

Influence of Site.—It is often said that a depressed fracture, even if distinctly marked, over the frontal sinuses, does not require operative interference, and that any such steps should be avoided for fear of leaving a fistulous opening leading to passage of air and troublesome emphysema. But it must be remembered that these sinuses do not appear before the age of fifteen or sixteen, and that, even in adult skulls, the extent of their development is most uncertain, the sinuses being sometimes represented by a small unilateral cell instead of fair-sized bilateral cavities.* Other sites, which it is well to avoid in trephining, if possible, are the position of large sinuses,† that of the trunk and chief branches of the middle meningeal artery,‡ and also the lines of

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[*] Hilton, *Guy's Hosp. Reports*, 2nd series, vol. viii. p. 362. *Notes on the Cranium*, p. 8 *et seq.* See p. 205, a case of fatal injury to this region.

[†] It is worth while to bear in mind that if a large venous sinus is opened into, the hæmorrhage is usually at once arrested by *very moderate pressure applied at the right spot.* The pressure should be made by a carbolized finger or sponge, and kept up if needful by a pad of dry aseptic gauze dusted with iodoform, left *in situ* for two or three days if possible. Dr. Cameron (*Lancet*, 1884, vol. i. p. 931) was able to complete a trephining while very slight pressure with lint controlled the bleeding from a wound in the superior longitudinal sinus. He points out that the imaginary fear of fatal hæmorrhage from such a wound may at times deter from a necessary operation with the trephine, and it is well that it should be dissipated. Dr. Hopkins (*Ann. of Surg.*, vol. ii. No. 7, p. 67), in a case of extensive compound fracture of the skull, found that a small lint-compress, dusted with iodoform, lightly applied to a wound in the superior longitudinal sinus exposed by elevation of fragments, readily arrested the hæmorrhage, which persevering efforts with tenaculum-forceps had failed to check with a ligature. Dr. Parkes (*Ann. Anat. and Surg.*, vol. viii. p. 118), in treating a wound caused by a fracture of the skull, arrested the terrific hæmorrhage first by pressure, and then by introducing three fine catgut sutures. These entirely closed the rent and controlled all bleeding, and though the calibre of the sinus was reduced fully one-third, and the sinus bulged markedly at the anterior extremity of the sutured wound, showing interference with the backward blood-flow, there was no evidence of cerebral disturbance due to this interference with so large a column of blood, the wound healing well with antiseptic precautions. The strictest antiseptic precautions should be made use of in dealing with wounds of these sinuses owing to the great risk of septic phlebitis and pyæmia.

[‡] The treatment of hæmorrhage from the middle meningeal artery is given at p. 178.

the sutures, apart from any subjacent sinuses, as here the dura mater is firmly attached, unless it chance to be loosened by a violent blow. *Age*, too, must have proper weight attached to it, it being well known that in the first few years of life a very considerable depression may take place after an injury, and yet be followed by absence of head-symptoms and by spontaneous recovery.*

iii. PUNCTURED FRACTURES.—Here, however slight is the injury to the outer table, that inflicted upon the inner is certain to be much more serious. And the more the diploë is present, the more extensive will be the damage which driven-down fragments of this will inflict upon the brittle inner table. It must be remembered that punctured fractures, with all their serious results, may be caused by blunt, though pointed, bodies, as well as by sharp ones.† Instances of these are, blows with a pickaxe, fragments of brickbat, coal, stone, the trigger of a clubbed gun, or falls on a fender-ornament. Immediate operative interference —and here, owing to the limited injury to the outer table, the trephine will be called for—is imperatively demanded in all punctured fractures, however insignificant is the damage to the scalp and outer table.‡

iv. IN SOME CASES OF FRACTURE ABOUT THE INNER ANGLE OF

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* Good instances of this are given by Mr. Le Gros Clark (*Diagnosis of Visceral Lesions*, p. 94); Mr. Bryant (*Surgery*, 2nd ed. vol. ii. p. 357); Prof. Nélaton (*Pathologie Chirurgicale*, tome ii. p. 149). The two last are accompanied by illustrations.

† Prof. Nancrede (*loc. supra cit.*, p. 18) points out that a punctured fracture caused by a sharp instrument may consist of merely a splitting off of a small scale of the inner table, but that a blunt-pointed body will comminute the inner table extensively by breaking up the diploë.

‡ "Hence it follows that exploratory perforation of the cranium is justifiable in all cases where the nature of the impinging force or the appearance of the external table renders spiculation of the inner table probable; provided that less danger to life and health is inherent in perforation than in the probable spiculation. . . . . I am driven to the conclusion that exploratory perforation to determine the absence or presence of internal spiculation is often demanded by the uncertainty of the invisible condition. Without a knowledge of the true state of affairs, treatment is empirical; and the risk to subsequent mental health or to life is too great to permit reliance upon empirical treatment when a knowledge of the true condition is obtainable with the slight danger that pertains to antiseptic trephining. Whenever the fracture, whether originally an open one or so made by any incision, presents the possibility of the inner table being detached and splintered more extensively than the outer, I should be inclined to advise perforation. In other words, I would cut the scalp to see the condition of the outer table, and I would cut the bone, to see the condition of the inner table, in every case where the risk of obscure knowledge is greater than the risk of divided scalp and perforated bone."—Dr. Roberts, *Ann. of Surg.*, vol. ii. No. 7, p. 14.

THE ORBIT.—The trephine should always be used (together with a small gouge) in exploring those grave injuries which may be caused by direct violence from thrust wounds at the inner angle of the orbit, or root of the nose—*e.g.*, with scissors, slate pencils, ferrules of walking-sticks, &c.

The apparent slightness of these injuries, the trifling wound, the period of latency of symptoms, and the onset of fatal brain mischief—inevitable, though delayed, if let alone—are all well shown in the following case of Mr. Hulke's :*—

" A little girl, aged six years, falling with a piece of slate pencil in her hand, it pierced her right eyebrow near its inner end, and broke short off. Admitted soon after into the Middlesex Hospital, the house surgeon took out of the wound several splinters composing, he thought, the whole piece, covered the wound with a pad of lint, and had the child placed in bed. Her general condition did not betray the serious nature of the injury. She slept quietly through the night, and next morning did not appear much worse for the accident. In the afternoon, when I then first saw the child, I detected with the probe another splinter of the pencil, and enlarging the little puncture exposed a piece of pencil tightly plugging a hole in the bone. Enough of this was cut away cautiously with a gouge to allow the pencil to be grasped with a forceps. It proved to be shattered, and splinters representing a cylinder three-quarters of an inch long were removed. Intracranial inflammation (indicated by convulsions, delirium, a high temperature—103°—and rapid pulse) supervened. On the ninth day after the injury the temperature fell to 97.5° (the child had passed a quiet night, and took her food better), and from this date it continued subnormal, or only slightly exceeded the normal average, until the sixteenth day, when it rose suddenly to 104°. With this elevation of temperature were associated restlessness, delirium, a flushed face, screaming, vomiting, convulsions, and coma. Death occurred about twenty-four hours later. At the necropsy a large abscess was found in the frontal lobe of the right hemisphere. It enclosed a piece of pencil about 1 inch long, and it had evidently quite recently burst into the anterior horn of the lateral ventricle. It is a matter of regret that the trephine was not employed instead of cutting away the bone around the pencil, which had the effect of loosening the splinters, and contributed to the fatal mistake that the whole piece of pencil had been removed."

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* *Syst. of Surg.*, vol. i. p. 586. As here pointed out, the injury is especially likely to be overlooked if the instrument has slipped under the lid, and so reached the roof of the orbit and base of the skull, leaving, it may be, merely a patch of ecchymosis on the conjunctiva.

v. For the Removal of Foreign Bodies Fissuring or Fracturing the Skull.—These are rare—*e.g.*, penknife-blades, pieces of stone, bullets, &c. To ensure certainty of complete removal the trephine will usually be required.

The following cases show how the gravest results may ultimately follow on the overlooking of a small piece of knife-blade. Both, the first case especially, are good instances of the long time which occasionally intervenes between the injury and the onset of urgent symptoms due to abscess.

The first case is given by M. Dupuytren.* "Il y a huit ou dix ans, un jeune homme reçut dans une querelle un coup de couteau sur le sommet de la tête; ce couteau se rompit dans la crâne, après l'avoir perforé. Le chirurgien qui pansa le malade n'examina point avec tout le soin désirable l'état de la plaie; il en rapprocha les bords, et le malade guérit. Plusieurs années se passérent sans accidents; seulement, de temps en temps, le malade ressentait des douleurs dans sa cicatrice. Au bout de quelques années, sans cause connue, il lui souvait un assoupissement très-fort de la fièvre; il vint à l'Hôtel-Dieu et y fut reçu. En examinant sa cicatrice, je sentis quelle était soulevée et dessous elle un corps étranger; j'incisai et fis l'extraction d'une portion pointue de lance de couteau, à l'aide du trépan. Les accidents persistèrent, il s'y joignit la paralysie du côte du corps opposé à celui de la tête qui était blessé. J'incisai la dure mère, il ne sortit rien; je plongeai un bistouri avec précautions dans le cerveau, et il jaillit de suite un flot de pus. Le soit même de cette opération, tous les accidents disparurent; la fièvre, la somnolence et le délire; et le malade guérit."

In the following case of Prof. Nancrede's,† the apparent slightness of the injury, the long absence of symptoms, then their sudden onset, the difficulties met with during trephining, the results of promptly meeting them, and finally death due to a hernia cerebri, are all deserving of careful attention.

On March 6th, J. Y., aged nineteen, walked into the Episcopal Hospital, complaining of a sore on the top of his head, the result of a blow received two months previously. On examining the wound, in the centre of an ulcer, located about the position of the left middle parietal lobe, was found the broken edge of a knife-

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[*] *Leçons Orales de Clin. Chirurg.*, 2nd ed. vol. vi. p. 146.

[†] *Intern. Encycl. of Surg.*, vol. v. p. 83.

blade. On being told of this he seemed thoroughly surprised. But little could be made out as regards the incidents of the attack, except that a man had struck him on the top of the head so forcibly that he had fallen on his hands and knees, but had recovered himself almost immediately. He said that he did not, at that time, nor afterwards, lose consciousness, nor had he had even a headache. All symptoms of brain injury were absent. He did not complain of any pain or uncomfortable sensation when the knife-blade was removed, but in the afternoon of the same day he had slight pains in the head. March 7th, had slept well. No headache, temperature 100°. Slight retinal hyperæmia. March 8th, epileptiform seizures set in to-day, beginning with twitching of the right arm, but soon becoming general. Prof. Nancrede trephined over the seat of injury, the bone removed showing a slight depression of the inner table. The position which the blade had occupied could be seen in the dura mater, there being an opening surrounded with dense cicatricial tissue. The dura mater did not seem to be congested, and there was evidently no pus or fluid beneath it. During the next three weeks the fits apparently ceased, but symptoms indicating cerebral abscess—viz., temperature often low, $97\frac{1}{2}°$–98°, slow pulse, marked mental dulness—set in. March 30th, temperature 99°, pulse 70. The patient was unconscious, with right-sided hemiplegia, and rapidly sinking. Prof. Nancrede, on reflecting the flap covering the trephine hole, found it filled by the tensely stretched dura mater, pulsating strongly. A small incision was made through this, but nothing was evacuated. The coma rapidly deepening, an aspirator needle, connected with a vacuum, was passed in at three or four different spots, to the depth of $\frac{5}{8}$ inch, but with no result. Feeling convinced that pus was present, and from the symptoms that it was compressing the ascending frontal and parietal convolutions, Prof. Nancrede proceeded to set a large-crowned trephine in front of and below the first opening, which was slightly behind the fissure of Rolando. Before the skull was half divided both pulse and respiration ceased. The operation being rapidly completed, the dura mater was incised without result. At this moment a large drop of pus oozed up through one of the aspirator punctures. A knife being plunged into the brain substance, from 1 to 2 ounces of pus were evacuated. The patient appeared to be quite dead, but vigorous and prolonged artificial respiration revived him. The next day a hernia cerebri as large as a walnut was protruding from the wound in the dura mater. This increased in size, and broke down, the patient dying on April 4th. At the autopsy the left parietal lobe formed an enormous abscess cavity, the abscess being superficial, and destroying the greater portion of the upper part of the left hemisphere.

TREPHINING[*] IN FRACTURED SKULL

(Figs. 46 and 47).

The scalp having been shaved and thoroughly cleansed (p. 240), the patient brought under the influence of chloroform,[†] unless a condition of unconsciousness renders this unnecessary, the head is supported on sand-bags at a convenient height. The fracture is next exposed, the old-fashioned crucial, T- or Y-shaped incisions being now, when possible, replaced by the semilunar flap of Prof. Horsley.[‡] The incisions should usually go down to the bone itself, and the pericranium should be raised, by the handle of the scalpel, cleanly and regularly off the bone, together with the flaps. If it be needful to operate through the temporal muscle, its fibres must be sufficiently severed and raised with the flaps, it being somewhat more difficult to separate the periosteum here, on account of its thinness in this region, and more intimate adhesion to the subjacent bones.[§] In reflecting scalp-flaps, free hæmorrhage is nearly always met with, especially in the case of the chief superficial trunks and the deep temporal arteries, but this is promptly and easily arrested by the use of Spencer Wells's forceps, which act as most useful retractors, taking up but little room, while at the same time they arrest the hæmorrhage. If bleeding continues from any crack in the bone which may now be found, it will only cease on the elevation of the fragment, or on the exposure of, and the dealing with, any subjacent clot. The fracture being now in view, and it being found impossible to introduce an elevator or pair of dressing-forceps, even after sawing off any projecting angle of bone, the surgeon must decide where to place his trephine. In doing so, he must choose a spot, if possible, clear of a sinus (p. 158), or large branch of the middle meningeal artery (p. 158),* and one which will at the same time support firmly the pressure needed in the working of the trephine. Thus the pin and the greater part of the trephine crown are placed on sound bone (Fig. 46), while a small part of the trephine usually overhangs a depressed fragment. But if the surgeon fears that the fragments are in contact with the dura mater, and perhaps injuring it, and that the jarring movement of the trephine coming in contact with one may be pernicious, he will so place his trephine that it rests entirely on sound bone, any intervening bridge being easily cut away (Fig. 47). A spot being thus chosen, a trephine of appropriate size is taken,† with the

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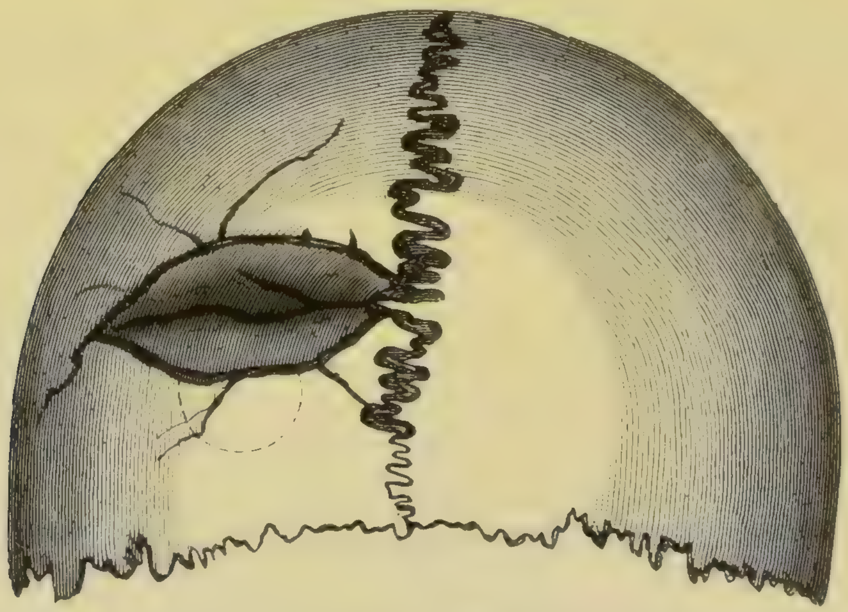
[*] It has been already stated that in many cases of depressed fractures, after exposure of the fragments, a pair of dressing-forceps and an elevator may do all that is required. That the trephine itself is not always needed should be clearly understood, as it is probable that elevation of fragments might most wisely have often been performed if it had not been for the absence of a special instrument, wrongly supposed to have been essential, or for the dread of an operation of undoubted severity with its necessary laceration of the vascular diploë, and requiring delicacy and skill also.

[†] I much prefer this anæsthetic, if possible, in these cases of trephining, on account of the greater excitement and congestion which are usually associated with ether. But whenever it is possible, and especially when the pulse and breathing are failing, anæsthetics should be dispensed with (p. 154).

[‡] See below, p. 241. The flap has these advantages :—(1) Readily detached, it easily carries the periosteum with it. (2) It exposes the bone freely. (3) It allows of more thorough use of antiseptics. (4) It prevents the occurrence of a hernia cerebri.

[§] The greater thickness of the soft parts which will here form the cicatrix will, in a measure, make up for the difficulty in preserving the periosteum.

FIG. 46.



Compound depressed fracture of gutter form. There being no comminution, the trephine has been placed close to, and, in part, overhangs the fracture (Hutchinson).

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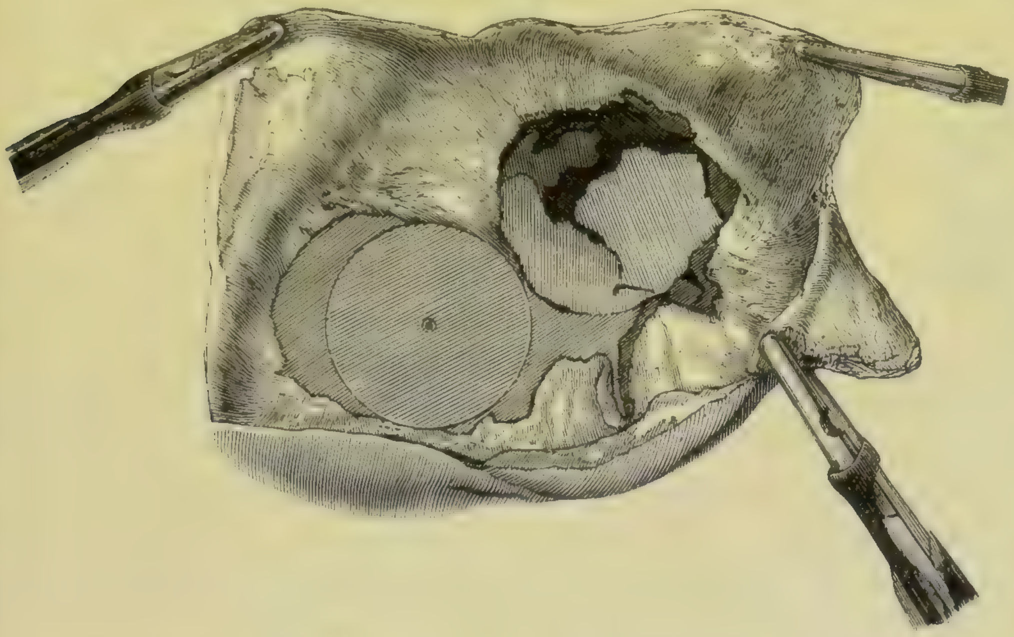
* If it is really needful to trephine over one of these vessels, the remarks at pp. 158, 178, will show how the hæmorrhage should be met.

† One $\frac{3}{4}$ inch in diameter is usually ample. The conical trephine is said by American surgeons (*e.g.*, Nancrede, *loc. supra cit.*, p. 96; Dr. Hopkins, *Ann. of Surg.*, vol. ii. No. 7, p. 69) to be safer than the ordinary one, it being almost impossible, owing to its greater steadiness, to injure the brain with it, if, as the deeper part of the internal table is divided, any undue pressure should be made. But if used with ordinary skill, the old form of trephine is perfectly safe. The modified burr of the dental engine has been found to work accurately by some

centre-pin protruded for about a tenth of an inch, and firmly fixed in this position, the trephine being so grasped in the hand, that the index finger steadies the centre-pin screw when the bone is entered. The instrument is now firmly applied to the bone, the centre-pin being bored inwards, and as soon as the teeth feel the bone, the trephine is worked from left to right and then from right to left, care being taken to exert equal pressure in both directions; while the first groove is being cut, the movements of the trephine must be light and quick, but without jerking, the tendency of the instrument to slip being met by steady bearing

FIG. 47.



Severe compound fracture of skull. The bone being much damaged by comminution, the trephine has been placed at a little distance from the fracture, so as to be on sound skull. The intervening bone would be readily clipped away with bone-forceps. The flaps are retracted, and cut vessels in them at the same time commanded by three pairs of torsion-forceps.

n the centre-pin, and by keeping the left forefinger at first on he bone, close to the trephine.

As soon as a groove has been cut sufficient to keep the rephine steady, the pin is drawn upwards, and so fixed. The otatory movements alternating from side to side are now coninued, care being taken to bear as evenly as possible on every art of the circle, till the diploë* (if this be present) is reached.

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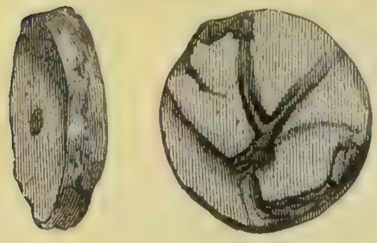
merican surgeons—*e.g.*, Dr. Roberts (*loc. supra cit.*), especially in removing large reas of bone. Hitherto, simpler, old-fashioned instruments have held their lace in England.

[*] This is absent in early life and in the aged. Again, over a large part of the quamous bone and in the occipital fossæ, diploë is never met with. Thus, in ases where the diploë is absent, especially in the thinned calvaria of an aged

This is known by the easier working of the instrument, and by the softer sound. On the living body at least, owing to the oozing from the vascular parts around, the blood-staining of the bone-dust described as taking place at this stage is liable to be fallacious.

Throughout the operation, but especially now as the thinner table is being reached, every care must be taken to keep the circle of equal depth—(1) by pressing on the saw evenly; (2) by making it bite in as equally from right to left as from left to right; (3) by remembering that, owing to the skull being spheroidal in shape, it is impossible, without the greatest carefulness, to keep the groove of equal depth all round; (4) by bearing in mind that while the average thickness of the adult skull is one-fifth of an inch, the thickness varies so much that it is almost always greater at one part of a trephine-circle than at another* (Fig. 48). Thus at frequent intervals the flat end of a trephine-probe, or a clean quill cut pointed, must be carefully introduced at different spots, and when the circle is found to be deeper on one side (still more if it is perforated) the trephine must be so slanted that its teeth are only cutting on that part of the groove which is still shallow. When the groove has been made sufficiently deep, and careful examination finds three or four points of penetration, the bone may be removed by inserting the elevator at the deepest part of the groove and lifting up the disc of bone by carefully making a fulcrum of the sound bone or of a finger.

FIG. 48.



If profuse hæmorrhage occur on raising either the disc of bone or a depressed fragment, it will probably come either from a branch of the middle meningeal artery or from a sinus. The treatment of the former is given at p. 178; in the latter case pressure should be at once applied by means of a piece of sponge which has been kept in and wrung out of a solution of carbolic

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corpse, it is quite possible, by using haste or force, to jam the crown of bone in upon the brain.

[*] Mr. Holden's words (*Landmarks*, p. 5) are excellent:—"Think that you are operating on the thinnest skull ever seen, and thinner in one-half of the circle than the other." Sir A. Cooper (*Surgery*, vol. i. p. 188) thus speaks of the operation:—"Some people say that this is a trifling operation, not difficult to perform, nor dangerous; but they deceive you: it is one of the most dangerous operations in surgery; whilst performing it there is but a single step—a small network—between your patient and eternity.

acid, or mercury perchloride, and dusted with iodoform powder; if this has to be tucked under an edge of bone to control the bleeding, a ligature of carbolized silk should be fastened on to it, to secure its withdrawal in about three days' time (p. 158).

In the case of a punctured fracture, a full-sized inch trephine should be applied, so as to remove the outer table around the immediate neighbourhood of the puncture, and thus expose freely the damage to the inner table.

If after removing a crown of bone more room is still required, this may be obtained either by taking out a second crown close by and joining the two, or by the use of a Hey's saw or Hoffmann's forceps; with the latter instrument, if of reliable temper, a considerable area of bone can be quickly nibbled away.

Mr. West recommends that the periosteum, which has been carefully preserved, should be adjusted with catgut sutures, this precaution tending to prevent any subsequent hernia cerebri. Sufficient drainage must of course be provided.

With the same view, in order to diminish the subsequent gap, any detached fragments of bone (which should have been kept in hot (T. 105°) bichloride solution) may be placed across the aperture in the skull, it having been found by Dr. Macewen* that they will adhere and give no further trouble. Any bone thus used must be rendered absolutely aseptic. If any fragments are too large, they may be cut up with a sharp bone-forceps or chisel. Sufficient drainage is then provided by fine tubes or drains of horsehair (a drainage-tube being always used where the dura mater has been opened, where the brain has been damaged, and in all cases of cerebral abscess), sutures inserted, and dressings applied.

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* *Ann. of Surg.*, Oct. and Nov. 1887. On this subject I would refer my readers to Dr. Macewen's cases (p. 93). Dr. Keen, of Pennsylvania (*loc. infra cit.*), in one case replaced the button of bone on the under surface of the flap, and secured it there with chromic gut ligatures passed through two openings made in the bone and then through the scalp. The bone was thus prevented from falling upon the brain, and its adhesion to the scalp secured. About five weeks later the bone was firmly adherent to the scalp, but not to the sides of the opening, as it could be moved by pressure. Mr. Clark (*Lancet*, 1886, vol. i. p. 243), in a case of trephining for traumatic epilepsy, in which this operation was followed by much improvement, but not a complete cure, replaced the crown of bone—a piece of the frontal, and the seat of ostitis—after bevelling off the inner edge so as to prevent pressure upon the dura mater, and after cutting a notch in the side of it to serve for drainage. The restored crown did not necrose, but united satisfactorily. However right it may be to replace, in most cases, bone which has been removed, especially in those cases where the removal has been extensive, I doubt very much if this course is judicious in cases of trephining for traumatic epilepsy. Until this subject has been more thoroughly worked out, I think it would be wiser to leave the small trephine-gap not filled up, and thus provide a safety-valve for the relief of varying tension. This course would be especially indicated in cases of long-standing depressed fracture where trephining is resorted to late, and though the source of irritation is thus renewed, the brain has taken an impression, which, though perhaps latent, will remain permanent, and which will be prone to show itself on very slight excitement. See footnote ‡, p. 156.

The terse summing up of Dr. Amidon (*Ann. of Surg.*, No. 3, vol. i.) may here be quoted: "Let the operation always be done with antiseptic precautions. Try and secure only proximate coaptation of the flaps. Provide the freest possible drainage. Use cold* antiseptic dressings, without much compression. Enjoin the strictest quiet in a posture facilitating drainage."

TREPHINING FOR PUS BETWEEN THE SKULL AND DURA MATER.

While the mode of using the trephine here will in no way differ from that already given, a few practical remarks will be made on this most important condition.

It is well known that operative interference here is now less frequent than it would appear to have been a hundred years ago when Mr. Pott drew the attention of surgeons to the need of trephining when pus was present immediately beneath the skull. For while Mr. Pott, in his day, saved five out of eight of these cases in which he trephined, surgeons of the present time, when they trephine, have been usually baffled by the co-existence of pyæmia, or, if this ominous complication be absent, by finding the collection of pus not localized between the bone and dura mater, or, if so localized, combined with suppurative arachnitis also.

Mr. Holmes (*Treat. on Surg.*, 1st ed. p. 130) brings forward the following weighty statements:—"Some years ago I published† the experience of St. George's Hospital in this particular for seventeen years—1841 to 1857 inclusive. Eight cases occurred in which the trephine was applied for pus. The pus was found in every case, but all the patients died. Seven were examined after death, and in six of these unmistakable evidence of phlebitis in the sinuses of the brain and veins of the skull and of general pyæmia was discovered. In the seventh case the abscess reached the ventricles of the brain. There were eight other cases in which the trephine was not used, and where matter was found above the dura mater, but it was not limited to this situation in any of these cases, nor would adequate exit have been procured for it by the trephine. In nine other cases there had been intra-cranial suppuration, but the matter was diffused among the membranes or in the substance of the brain, and lay entirely below the dura mater."

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* Boracic acid lint and iodoform, the dressing kept moist with iced boracic acid, is soothing, and gives excellent results when the patient is not restless.

† *Brit. Med. Journ.*, October 16, 1858.

The above most gloomy picture of what has been usually met with only serves, I think, to confirm the opinion given below that these cases should be explored early, being treated, in short, more like cases of acute periostitis and osteo-myelitis elsewhere, than has hitherto been the case.

When it is remembered that pus does not form between the bone and dura mater without a previous stage of traumatic ostitis and phlebitis of the veins of the diploë, it will be readily understood how easily, if the wound be foul, septic osteo-myelitis and septic phlebitis, with the inevitable result of pyæmia, will follow.

Indications of the Formation of Pus between the Bone and Dura Mater; Question of Trephining.—History of a head injury with damage of some kind to the outer table. Thus there is often a scalp wound exposing the pericranium, often opening this up at one or two points, perhaps small and not seen at the time; occasionally the bone itself is laid bare by the injury. Either now or later on the wound becomes septic. After a varying period, usually in the course of the second week after the injury (during which period definite symptoms are often absent), headache, fretfulness, nausea, or vomiting sets in, gradually followed by drowsiness, delirium, twitchings, convulsions, paralysis, coma, and death.

This on-rush of symptoms about the eighth or tenth day may be accompanied by evidence of pyæmia—viz., rigors followed by sweating, a jactitating temperature, progressive emaciation, and affections of viscera and joints, amongst which pleuro-pneumonia is one of the most frequent and grave.

The surgeon who is watching a case of this kind, and also is not unmindful of what has happened and what is liable to be going on—the injury to the pericranium and bone, the ostitis and osteo-myelitis with plugging of the diploic veins, the extension to the inner table, the formation between the bone and dura mater of lymph ready to suppurate, this deep-seated inflammation being only too ready to extend to the arachnoid and thus become a diffused meningitis—will find it a matter of much difficulty to answer the question, How far has the mischief gone? Is the case a hopeless one? If the intra-cranial collection of pus be a localized one and uncomplicated, well-marked hemiplegia and the absence of pyæmic symptoms will call hopefully for trephining. On the other hand, paralysis, indistinct or complete, epileptiform convulsions, extreme irritability, an aspect of fever, and, especially, any evidence of involvement of nerves at the base, will all point to that form of meningitis which will show itself as a diffuse layer of pus and lymph over one side of the arachnoid.

Equally pointing to a fatal issue will be the symptoms of pyæmia already alluded to, and needing no further mention here.

What is to be done in these cases? Where the evidence of meningitis is undoubted, of some days' standing, where the hemiplegia has been little marked, or where it is replaced by paraplegia, general convulsions, and other unfavourable signs, no surgeon will be wise in trephining.

Should evidence of co-existing pyæmia be looked upon as equally hopeless and equally negativing the use of the trephine? I scarcely think so. Every surgeon knows that, although pyæmia is usually fatal, it, very occasionally, ends favourably. Again, in treating pyæmia resulting from periostitis and osteo-myelitis elsewhere, we are not deterred from making free incisions and exploring the bone.

The real treatment of these cases must, of course, be really preventive—*i.e.*, every scalp wound should be rendered aseptic and kept so from the very first, however slight it seems to be. But, as this precaution is not always taken, and is occasionally impossible, the condition of the pericranium and bone should be explored earlier, at the very first warning of danger. Instead of treating such a case as a special result of head injury, and waiting for evidence of pus between the bone and dura mater, we should, I think, deal with it as we do with periostitis and ostitis elsewhere; that is to say, that, in cases of this kind where there is reason to believe that the bone has been injured, especially if there is any doubt as to the condition of the wound throughout, the surgeon should, on the first appearance of malaise, irritability, headache, nausea, chilliness, explore the wound. Any granulations here present will very likely be at a standstill. A piece of bone will probably be bare and perhaps soft, the pericranium infiltrated and separating. The whole area of bone which is thus being deprived of its pericranium should be explored, and drainage provided. But in nearly all cases, especially if the bone is softened at all, it will be wiser to do more, and open the bone with a trephine to give vent to any inflammatory material in the diploë, to prevent septic phlebitis and its extension to the sinuses.

and to save the inflammation from reaching the inner table and dura mater.

The above depends on the fixed conviction that trephining, in careful hands, and with due precautions, is not, in itself, a dangerous operation (p. 155), and on the fact, which is beyond dispute, that, if these cases are left till hemiplegia pronounces the existence of intra-cranial pus, they will, too often, be left too long, as this waiting will give time for the onset of pyæmic infection, and for the arachnoid to be involved in the inflammation.

The operation of trephining here will in no way differ from that already described. Pus welling up from the diploic cancelli, or a fetid condition of these, is ominously suggestive of impending pyæmia. If such a condition be present, the bone should be freely removed, and disinfected as far as possible; but, from the probable extension of thrombi to the sinuses, the outlook is a very dark one. If pus be present between the bone and dura mater, it must be thoroughly evacuated, and free drainage provided.* The condition of the dura mater should always be examined into, whether pus is found superficial to it or no. If it pulsate freely and be natural in appearance and devoid of lymph, nothing more need be done. If, on the other hand, it bulge into the trephine-hole devoid of pulsation, it should be punctured, this perhaps giving vent to a jet of purulent fluid from the arachnoid cavity. If the arachnoid is seen to be covered with lymph, this is of the gravest omen. The possibility of the existence of cerebral abscess must always be remembered in these cases, where nothing else has been found to account for the head symptoms. The symptoms and treatment are fully given at p. 181.

The following cases are good examples of this most dangerous condition of ostitis of the cranium and its sequelæ and complications:—

The first case, reported by Mr. Hutchinson,† shows pyæmia prominent rather than arachnitis; the second,‡ also Mr. Hutchinson's, shows the reverse condition—much arachnitis and no general pyæmic infection. The third, one under my own care, shows both arachnitis and pyæmia combined. In all pus was present between the bone and dura mater.

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[*] In these cases, and, in fact, in any trephining cases where the discharges are foul and the scalp the seat of cellulitis or erysipelas, iced boracic acid (a saturated solution) lotion applied by means of lint frequently wetted and renewed, together with a dusting of iodoform, is preferable to dry dressings changed less frequently.

[†] *Clin. Surg.* vol. i. p. 97.

[‡] *Loc. supra cit.* p. 102.

J. W., aged ten, on October 15 received a large lacerated scalp wound from a dog bite, a triangular flap of all the tissues of the scalp being torn up from the left parietal bone. The pericranium was not torn up, excepting perhaps at a few points. The boy was admitted into the London Hospital at once, the flap of skin adjusted, and for some time all went on perfectly well, the boy being only kept in bed for a day or two. Oct. 29.—While up and at dinner he was noticed to be cold and shivery. A very severe rigor followed. It was impossible to ascertain whether he had had headache for some days or not. In the wound the granulations were pale and glassy, and a small piece of dry, bare bone was exposed. During the next few days there were repeated rigors. Nov. 1.—He had now very decidedly the aspect of pneumonia, and the breathing, temperature, pulse, and cough confirmed this. Nov. 2.—He seemed better than yesterday, the respiration being more easy. There is not the slightest sign of paralytic weakness. Doubts have been expressed as to whether this boy is or is not the subject of pyæmia. He looks comfortable, excepting for the blueness of the lips, which is less than yesterday. That he is suffering from pneumonia all must admit, and that the pneumonia does not produce the usual train of symptoms (no rust-coloured sputum, no great dyspnœa, &c.). If there had been but a single rigor, it is very possible that it might have been indicative only of pneumonia, but their recurrence seems to me to denote pyæmia. This diagnosis is also favoured by the fact of his apparent improvement at times and great variations in condition. The wound was now secreting a very fair quantity of healthy pus. Its granulations are much better than they were, and fairly florid. During the next three days the thoracic symptoms increased. He emaciated rapidly. Consciousness was perfect to the last, and he had neither paralysis nor convulsions. All traces of granulations disappeared from the wound. He died November 7. There were very numerous pyæmic deposits in the lungs, liver, and spleen. Beneath the scalp wound was bare and greenish bone the size of a crown-piece. The edges of the wound and the pericranium were loose over a surface as large as the palm of the hand, comprising, in fact, nearly all the parietal bone. There was a recent scar in the scalp, crossing the vertex transversely, just above the lambdoid suture; the pericranium here was thickened and inflamed, and the bone on both sides of the sagittal suture here was green. On applying the trephine at this spot, dirty-green, fetid pus exuded on the inner surface of the bone. It must be observed that this portion of inflamed bone extended on each side of the sagittal suture, and that it was under, not an open wound, but a soundly healed one.

E. S., aged ten, was admitted, July 21, into the London Hospital with very extensive laceration of the scalp on the left side, laying bare the parietal bone. During the first few days he seemed to be doing well. July 26.—Bone as large as a crown-piece is exposed, white and dry, above the left ear. July 29.—A strong rigor. July 30.—Wound without granulations, looking glazed. July 31.—Very restless. Uses all his limbs at times, but the left ones much better than the right. Aug. 1.—The skull was trephined in the middle of the exposed bone 2 inches directly above the left ear. The dura mater was covered with yellow lymph. It pulsated pretty freely. On cutting through it, about a drachm of thin, purulent fluid jetted out. The visceral arachnoid was seen to be covered with lymph. Aug. 2.—He still uses his left arm, but never his right hand. When the brain, which bulged, pulsating, into the wound was pressed back, thin pus ran out in considerable quantity from the arachnoid cavity. His aspect was that of a patient in the very last stage of fever. Death took place on August 3. The bone around the trephine-aperture was dry and green. Everywhere on the left side the parietal arachnoid was concealed by a thick deposit of puro-lymph, whilst everywhere on the right side the membranes were perfectly free from deposit, polished and glistening. The superior longitudinal sinus contained puriform fluid. The skull at the seat of injury was discoloured over an extent almost as large as the palm of the hand; adjacent to it were other patches, greenish-yellow, opaque, and non-vascular. There were no pyæmic deposits in the lungs or in the viscera of the abdomen.

E. S., aged forty, slipped while getting off an omnibus, January 22, 1877, and was admitted into Guy's Hospital under Mr. Howse's care with a scalp wound 4 inches long exposing the right parietal bone. Owing to some oversight the wound was not dressed at first antiseptically,* the discharge became offensive, and, erysipelas of the scalp setting in, she was transferred to my care on February 1. At this time almost the entire right parietal bone was exposed, owing to sloughing of the pericranium. Incisions were made where needful, drainage-tubes introduced, and in a few days the erysipelas had subsided, and the wound was sweet. Feb. 11.—She had a rigor for the first time. Feb. 13.—There was some paralysis of the left side of the face and the left limbs. The temperature was 104°. Feb. 15.—The hemiplegia becoming more marked, I trephined through the exposed bone, about 1 inch above the right parietal eminence. Pus was met with in the diploic cancelli. On removing the crown of bone, an ounce of thick, foul, greenish pus welled up. The inner surface of the bone was very rough, the dura mater which corresponded to it being covered with velvety granulations. As the dura mater did not pulsate, it was punctured, but without result. The patient became more conscious after the operation, but soon lapsed again into a semi-comatose state. Convulsive seizures of all the limbs, with twitchings of both sides of the face, then set in, and continued till the patient's death, on February 17. The parietal bone was found to be dying for a considerable area, the diploë being green and offensive. The pus seemed all removed from the dura mater, but there was suppurative arachnitis over the right hemisphere, reaching up to the falx in one direction and the base in the other, but stopping short of each. There were numerous pyæmic abscesses in the lungs and liver.

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* A precaution on which my colleague habitually insists.

TREPHINING FOR MIDDLE MENINGEAL HÆMORRHAGE [*] (Figs. 49, 50).

Indications.—When a patient, after receiving an injury to the head, has shown several of the symptoms given below.

It is noteworthy that the injury and amount of violence vary extremely. While most frequently serious, as in falls on the head, the violence may be extremely slight, as when a patient slips going downstairs and strikes the head against the wall, when a boy receives a blow from a cricket-ball, or when a child has a fall of 2 feet 6 inches out of a swing. From this the following conclusions follow naturally:—(*a*) That in the cases of severer violence, laceration or contusion of the brain are, only too frequently, complications; (*b*) where the violence has been slighter, either no fracture may be present, or, if one be present, it is often only a mere fissure, and may involve the internal table only.

i. *Interval of Consciousness or Lucidity.*—This interval between the stunning effects of the injury or concussion and the onset of compression from the effused blood varies, when present, in length from a few minutes to several hours. In about half the cases it s well marked. In a second class it is but little marked, and may easily be overlooked altogether. In a third and last set of ases this interval is never present at all, owing to (1) The presence of a very large hæmorrhage, producing compression-ymptoms; (2) Co-existing depression of bone; (3) Co-existing njury to the brain; (4) Drunkenness of the patient.

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[*] For fuller information on this most important subject, I may, perhaps, refer the reader to an article contributed to the *Guy's Hosp. Reports*, 1886, p. 147.

ii. *Condition of the Limbs as to Hemiplegia, Paralysis, Rigidity, &c.*—Hemiplegia, though well marked in a large proportion of cases, must not be looked upon as essential, and middle meningeal hæmorrhage must not be overlooked because hemiplegia is absent, ll-marked, or replaced by some other condition of the limbs. At east, the following seven conditions of the limbs may be met with in middle meningeal hæmorrhage.

(*α*) Hemiplegia present and well marked, the leg or arm, and usually both, when taken up and let go, dropping like those of a corpse. This condition is present in probably one-third of the cases. It is noteworthy that occasionally the hemiplegia is on the same side as that injured, the extravasation taking place on the side opposite to that struck.

(*β*) Hemiplegia present, but little marked. In these cases, which are not uncommon, the extravasation may be overlooked. They fall into at least two divisions. In one the hemiplegia is little marked throughout, owing, perhaps, to some power of accommodation on the part of the brain, or to the circulation remaining feeble, owing to co-existing shock from the time of the injury to the moment of death.

In another group of cases the hemiplegia is ill marked because of brief duration, coming on as it does in these cases towards the close, together with coma, giving but little warning and leaving but short time for interference.

When there is any doubt as to the existence or degree of hemiplegia, the following tests should be carefully made use of: whether the patient resists on the surgeon attempting to move the limbs; the power of the grasp, if any; the result of pricking; whether the patient moves either of his hands, or which of them, when the cornea is carefully touched, or the cilia gently pulled.

(*γ*) Hemiplegia present, but temporary. A very rare condition, produced probably by the brain being able to accommodate itself to the blood.

(*δ*) Monoplegia, or the paralysis more marked in one limb than the other. A rare condition, as the hæmorrhage generally makes pressure upon all the motor area.

(*ε*) General paralysis. Another rare condition, the existence of which may be explained by a very large clot—*e.g.*, on the left side, rapidly effused and making pressure through the left side of the brain, upon the right as well, or by co-existing extravasation into the brain substance itself.

(ζ) Absence of any paralysis. A very rare condition, and one which is, perhaps, due to the blood effused from the middle meningeal artery, finding its way through a fracture in the skull, beneath the scalp.

(η) Limbs rigid, convulsed, or twitching. It is only too probable here that, in addition to middle meningeal extravasation, contusion, or laceration of the brain substance will be found at more spots than one.

iii. *Condition of the Pupils.*—Whilst this may be various, there are at least three conditions which are most important.

(α) If the pupils are natural as regards reaction to light, the compression of the brain is probably recoverable if trephining is immediately performed. Furthermore, it is probably a case of compression only of the brain, without other injury.

(β) If the pupils are insensitive, often at the same time dilated, the compression is probably extreme, and while trephining is urgently called for, it is less probable that in these cases the brain will recover itself after removal of the clot.

(γ) If one pupil is found widely dilated, the other being natural or contracted in size, and if the dilatation be present on the side injured, in other words, opposite to the side paralysed, it is a most valuable sign, the explanation of which we owe to Mr. Hutchinson.*

Taken with other evidence of middle meningeal extravasation, this condition of the pupil points to a large clot, reaching down into the base and pressing forwards upon the sphenoidal fissure, and thus compressing the third nerve.

iv. *The Pulse.*—This will vary according as the case is one of well-marked, uncomplicated extravasation, or complicated with contusion or laceration of the brain ; and, if the concussion stage has been severe, according to the degree to which the heart has recovered from this.

In well-marked uncomplicated compression, the pulse will be slower than normal—*e.g.*, 66, 52, and still falling, 42, and usually somewhat full and labouring.

v. *Coma, or Unconsciousness.*—With regard to this, the following points should be borne in mind :—

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* On Compression of the Brain : *Lond. Hosp. Reports*, 1867, vol. iv. p. 29.

(α) The degree of unconsciousness will vary with the size of the branch injured, and the rapidity with which the blood is effused. Where the effusion is rapid and the compression great, the coma may be as deep and complete as in apoplexy. But, in other cases, it will be found that though the coma is apparently deep, this is not really so; thus the patient may moan constantly, or may move his limbs feebly when disturbed.

(β) The commencing coma may be taken for natural sleep, or drunkenness, in which conditions the patient may be allowed to lie till it is too late.

(γ) In a few cases, the onset of the coma is deferred till late; its onset is here sudden, its course rapid, and it generally ends in death.

vi. *Respiration.*—This, in well-marked cases, is often stertorous and somewhat slow. In cases where stertor has not supervened to call attention to the existence of compression, other and still graver alterations in the breathing may be present, alterations which are warnings that the end is not far off, and that, in the case of intended trephining, there is no time to lose—viz., catchy, short respirations, cyanosis, and gasping, irregular breathing, ceasing for intervals of ten or fifteen seconds, and then repeated.

vii. *State of Scalp.*—When the history is deficient, or when the signs of compression are not well marked, ecchymosis or contusion of the parietal and temporal regions giving rise to a pulpy or puffy feel are of great value. This condition will be especially marked, when the hæmorrhage from the middle meningeal artery is finding its way through some fracture into the tissues of the scalp.*

Treatment.—Early trephining should be performed as follows:—The scalp should be shaved widely, for the liberal application of ice, later on, if needful. No anæsthetic should be given if the patient is unconscious, or the respiration failing. The head being supported on sand-bags or a firm pillow, the middle meningeal area on the side which is bruised, and on the side opposite to the hemiplegia, is explored by turning up a semilunar flap, the centre of which is 1½ inch behind the external angular process, and 1 inch above the zygoma, or Kronlein's point of election in doubtful cases may be made use of. This is from 1¼ to 1½ inch behind the external angular process, on a line drawn backwards from the upper margin of the orbit. This will expose a diffuse, a temporo-parietal and a fronto-temporal hæmatoma. If the first perforation prove fruitless, a parieto-occipital hæmatoma is to be sought for by a second perforation made over the posterior branches of the artery. The best point for this is on the line above given, prolonged backwards, at its intersection with a vertical one carried up directly behind the mastoid process (*Deutsch. Zeitschr. f. Chir.* Bd. xxiii. Hft. 3 u. 4, March 1886). The brisk hæmorrhage which takes place from the scalp will be best arrested by applying Spencer Wells' forceps to the bleeding points, the forceps thus not only arresting hæmorrhage, but acting as retractors also (Fig. 47). The pericranium is then carefully separated, and any fissure or fracture looked for on the bone. Whether one is found or no, a crown of bone is next removed with a full-sized trephine. When this has exposed the clot,* hæmorrhage may be still going on, warning of which will, perhaps, be given by the pulsation of the clot. This being removed by a small lithotomy scoop, one of Volkmann's spoons, or the handle of a small teaspoon, the hæmorrhage may cease, or it may continue profusely, welling up from a point quite out of reach. In such cases, the surgeon may, after saving his patient from the dangers of compression, have to face those of most serious hæmorrhage. In such a contingency, the following steps may be made use of:—(1) The use of cold, either in the shape of large ice-bags over the side of the face, head, and neck (M. Beck), or, as a freezing mixture, three parts of salt and two of ice (Howse); (2) Pressure, by suturing the edges of the wound,† or by digital pressure on the common carotid; (3) If the bleeding spot is found by the aid of a pointed probe to lie in a distinct bony canal, the hæmorrhage may, perhaps, be arrested by plugging this canal with a tiny wooden peg;‡ (4) The above means failing, which is unlikely, ligature of the external carotid had better be resorted to.*

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* There is a good specimen of this in St. George's Hospital Museum, Series No. 4, figured by Mr. Holmes in his *Surgery*, 4th ed. p. 140, fig. 39. It shows the parietal bone of a child, in which a gaping fissure crosses the middle meningeal artery, producing considerable extravasation inside the skull, and still more externally. I have lately trephined successfully in a similar case.

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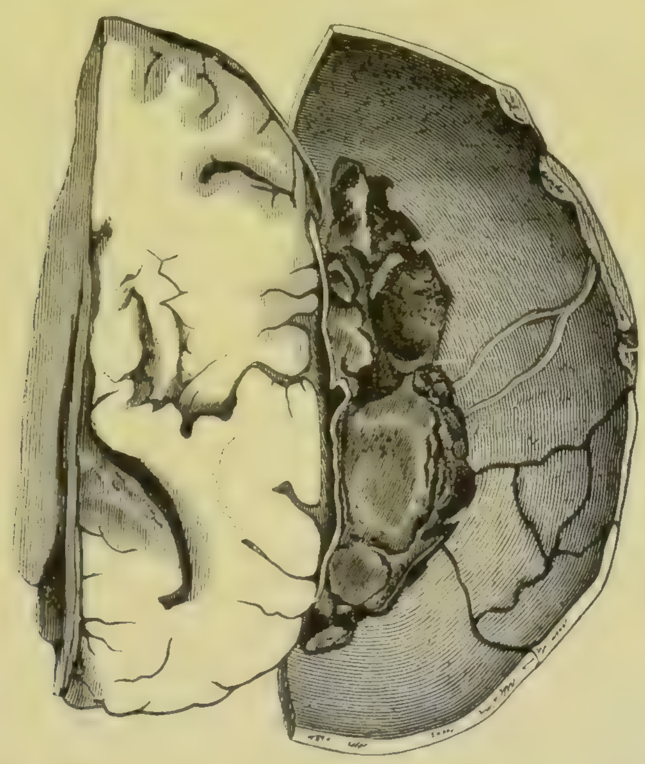
* Perhaps another crown must be removed for this. Thus, in one case, when trephining over the trunk of the middle meningeal, I came down on the prolonged tail-like extremity of a huge clot, reaching far away upwards and backwards, and due to a branch being opened at some distance by a most extensive fissure.

† This can only be carried out when the edges of the wound are clean cut, and also when the surgeon is able to see his patient at short intervals, or to leave him in competent hands; otherwise, if the hæmorrhage persist, this precaution may increase the risk of that compression which the operation had been intended to obviate.

‡ This was suggested by Mr. T. Smith, and used successfully by Mr. Willett and Mr. H. Marsh, at St. Bartholomew's Hospital, in cases of hæmorrhage from the descending palatine artery (*Clin. Soc. Trans* vol. xi. p. 71).

Whether the surgeon should remain satisfied with a single trephining and partial removal of the clot, or, having exposed the clot, proceed to remove the skull, and then the blood, more extensively, is as yet doubtful. For the present, and until a larger number of cases in which trephining has been performed for this hæmorrhage have been collected, that surgeon will probably be wiser who rests satisfied with a simple trephining, using a full-sized instrument and trusting to the "safety-valve action"† which this ensures for the brain.

FIG. 49.



Middle meningeal hæmorrhage with extensive fracture of the skull. Prep. 1593^{61}, Guy's Hospital Museum. From the severity of the fracture which involves both vault and base such a case gives very little hope.

Prognosis.—With reference to this point, I may quote the following remarks from my paper in the *Guy's Hosp. Repts.*, vol. xliii. :—

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* Ligature of the common carotid, if preferred, is justified by a successful case recorded by Dr. Liddell (*Amer. Journ. Med. Sci.*, vol. lxxxi. p. 344), in which secondary hæmorrhage from the middle meningeal artery, three weeks after a shell wound in the temporal region, was successfully arrested by ligature of the common carotid. The additional special risks of this operation are, however, well known.

† Mr. Marcus Beck, *Med. Times and Gazette*, 1887, vol. ii. p. 199.

"The chief points on which this depends are, whether the middle meningeal extravasation is probably complicated with such injuries as extensive fractures and brain injury, and secondly upon the date of the trephining, and whether, at this time, the brain recovers itself quickly or not. With regard to the former, or the existence of complications, the surgeon will, if asked to state the probable result, base his opinion on the history of the case, the severity of the violence, *e.g.*, height of fall, whether any interval of lucidity has been present, and, if so, for how long and how far this has been well marked, how far the symptoms of compression, well-defined hemiplegia, the falling pulse, the stertorous breathing, &c., are present or replaced by, or complicated with, those symptoms which are believed to point rather to laceration or contusion of the brain and its membranes—viz., restlessness, convulsive movements or twitchings, pulse quick and sharp, and other evidence of pyrexia, which show that inflammation of the brain has probably supervened upon the injury to its substance."

The seventy cases on which the above paper was based appeared to fall into the three following groups :—

A. *The Most Hopeful Cases for Trephining.*—Violence comparatively slight; laceration of middle meningeal artery or its branches; fracture of skull, if present, slight and localized to side of skull, *i.e.*, not implicating the base; compression, but little or no contusion or laceration, of brain. 27 cases.

B. *Less Hopeful Cases.*—Violence greater; laceration of middle meningeal or its branches; fracture implicating middle fossa; some injury to brain, but this only trivial. 20 cases.

C. *Cases probably Hopeless from the First.*—Violence very great; laceration of middle meningeal or its branches; fracture of skull extensive, perhaps implicating several bones and sutures both in the vault and base; injury to brain very severe. 23 cases.

If no blood is found superficial to the dura mater, this membrane should always be opened with a fine-pointed bistoury, especially if it bulge up without pulsation; otherwise that much rarer condition, an infra-dural hæmorrhage, may be left unrelieved.*

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* Compare an interesting case successfully treated by trephining, by Mr. H. Allingham (*Brit. Med. Journ.*, 1889, vol. i. p. 887), and one not so treated, *Lancet*, 1890, vol. i. p. 541.

TREPHINING AND EXPLORATION OF CEREBRAL ABSCESS DUE TO INJURY.

Indications for Exploring; Symptoms and Diagnosis of Traumatic Cerebral Abscess.—Many of these are given at somewhat fuller length when that form of cerebral abscess which, as one of the results of otitis media, is discussed at p. 200. To begin with, there is the history of an injury * with primary brain symptoms—*e.g.*, concussion lasting a variable time, but usually brief. If no such injury as fracture and depression of the skull exists, and if no laceration, &c., of the brain has occurred, there now often follows a latent period devoid of brain symptoms, which may last from a few—*e.g.*, four—days to three or four weeks or much longer.† This latent period is succeeded by brain symptoms increasing in severity and going on to those of compression—viz., headache felt over the side injured, but not necessarily most intense at the injured spot; nausea or vomiting; some pyrexia, but the temperature usually rises slowly, if it rises above normal at all.‡

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* This may have been a stab with a knife, p. 161, a graze of the head with brief concussion, a fracture, a blow with a stone, a glancing bullet, &c. But the help in the case which the history of an injury gives is not always present, and this is an indication for always examining for any wound or scar and exploring it, however unimportant it may seem to be, in these cases. Thus, in the following case (Hulke, *Syst. of Surg.*, vol. i. p. 626), the necrosis might have been overlooked, and the fit and rigidity put down to another cause. A middle-aged woman, having fallen down in a fit, was brought to the Middlesex Hospital. She was unconscious, and her left arm and leg were rigidly flexed. On her right temple was a small festering wound, leading to necrosed bone. On perforating this with a trephine, pus was forcibly ejected through a sloughy hole in the dura mater. The spastic rigidity of the left arm and leg immediately disappeared, but the patient soon died. A large abscess-cavity was found in the anterior lobe of the right cerebral hemisphere.

† As in M. Dupuytren's and Prof. Nancrede's cases at pp. 161, 162; so, too, in a case of Mr. Hulke's, alluded to in a foot-note, p. 182, the patient, an errand boy, continued to work for seven weeks after the injury, more or less headache being present all the time, retching and hemiplegia then coming on.

‡ On this point I would refer my readers to p. 198. Dr. Nancrede (*loc. supra cit.*, p. 95) writes thus:—"I believe that an abscess involving the cerebral tissue alone will be accompanied, in most cases, by a subnormal, or, at least, a normal temperature. Where a high temperature is noted, either the pus collection is a localized suppurative arachnitis limited by adhesions, or there is a meningitis in addition to the abscess." Dr. Nancrede quotes briefly a case recorded by Dr. H. L. Brown (*Bost. Med. and Surg. Journ.*, December 29, 1881, p. 610) in which the temperature was 97° for eleven days. Mr. Hulke (*Syst. of Surg.*, vol. iii. pp. 627, 628) gives two cases of cerebral abscess, in which he trephined success

Other symptoms are mental dulness, the answers long delayed but intelligent when they come, a slow pulse, perhaps rigors, progressive emaciation, perhaps accompanied by vomiting. Whether local nerve symptoms—*e.g.*, disturbances of sensation and motion—are present must depend on the position of the abscess. If the injury has been over the motor area (Fig. 53), nerve symptoms may be clearly marked; but if over the anterior part of the frontal, or temporo-sphenoidal [*] lobes, they may be entirely absent. Thus hemiplegia,[†] a paralysis limited—*e.g.*, of upper limb, and, later on, gradually increasing—epileptic seizures, spasms, spastic rigidity, all have been met with, but must by no means be relied upon, and even when paralysis is present it may escape observation, as when there is slight paralysis of the muscles of the lower half of the left side of the face, and some loss of power in the left hand and arm, but only temporary.[‡]

Finally, the surgeon, who is watching what he believes to be a cerebral abscess, must always remember that after a period of

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fully; the temperature was subnormal in both. More rarely, the temperature shows fluctuations, as in a case of Dr. Burney Yeo (*Brit. Med. Journ.*, 1879, vol. ii. p. 84). More rarely still, the temperature continues high throughout, and the case may be mistaken for one of continued fever.

[*] With regard to the large collections of pus often found here, Dr. Yeo (*loc. supra cit.*, p. 885) quotes as follows from Hugenin (Ziemssen's *Cyclopædia*, vol. xii.):—"The difficulty of diagnosis is increased by the circumstance that no bands of fibres, which are direct conductors of sensibility, or motion," pass through this lobe; and, therefore, an abscess here "may attain a considerable size, and may cause general symptoms of compression before any distinct symptom of local disease arouses the suspicion of a localized affection of the brain."

[†] Mr. Hulke, in relating the case of a boy which he brought before the Medico-Chirurgical Society, March 11, 1879, laid stress on the fact that hemiplegia occurring some time after an injury to the head was significant of disease in the brain itself rather than of arachnitis.

[‡] The value of accurately noting symptoms which, though of but brief duration, may be very important guides in treatment, is well shown by a case of Dr. Macewen's (*Lancet*, 1881, vol. ii. p. 582). A boy, aged eleven, was admitted into the Glasgow Royal Infirmary, two weeks after a fall upon his head, with a partially healed wound and bare bone over the left eyebrow. A week later he had a rigor considered to indicate the probable formation of pus. Five days later, or twenty-six days after the injury, the patient had a convulsion confined to the right side; when this had passed off, he was distinctly aphasic. The seat of the abscess now seemed to be the third left frontal convolution, and trephining was proposed. The friends, however, refused to permit this, as the patient had recovered consciousness, though they were warned that the improvement would be only temporary. Thirty hours later, the convulsions of the right side recurred, the temperature rose quickly from 101° to 104°, and the patient died before the operation could be performed. The situation of the abscess was verified after death.

latency, which may last weeks or more, acute symptoms may set in suddenly and quickly close in death.*

Operation of Trephining for Traumatic Cerebral Abscess.—As the fatality of cerebral abscess, if left to itself, is so high—90 to 100 per cent.—trephining is abundantly justified, but it must be conducted aseptically for fear of setting up suppurative meningitis and brain softening. The chief difficulty is, of course, hitting off the seat of the abscess, especially in cases where there are no definite nerve symptoms to guide, and where the history of the part of the head injured is indefinite also. To obviate the necessity of multiple trephining Dr. Fenger and Dr. Lee, of Chicago, have recommended,† as easier and safer, exploratory puncture and aspiration. This must be done methodically with a needle, 4 inches long, set in a large-sized hypodermic syringe. The needle should not be too fine, and the gauge should be powerful enough to make sufficient suction, as a fine needle is readily plugged with brain-substance. This may be easily taken for pus. The needle, well disinfected, is pushed, through a trephine hole, straight in in a definite direction for ½ inch or 1 inch; the piston is then withdrawn a little, and, if no pus follows, the needle is pushed ½ inch further, and the piston again withdrawn. The depth to which it will be permissible finally to push the needle will, of course, vary with the position of the trephine-opening and the direction of the puncture, the surgeon being guided by the anatomy of the brain. The punctures are to be repeated at intervals of ½ inch or 1 inch, the utmost care being taken to push the needle in straight, and to avoid all lateral movements. If, after a reasonable number of punctures no pus is withdrawn, the operator may feel convinced that no pus is present. An abscess in the brain is usually as large as a walnut, often much larger.

Puncturing healthy brain tissue with a fine perfectly aseptic needle can do but little mischief.

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* The sudden cessation of breathing in cerebral cases is again noticed at pp. 154, 177. So, too, in a case which Mr. Gamgee brought before the Medico-Chirurgical Society, June 14, 1879. A boy, who had been trephined for suspected cerebral abscess, the pus not being found, suddenly ceased breathing the day after the operation. The patient, though apparently dead, being partly revived by artificial respiration, the dura mater and brain were now incised—a step which had not been taken before, as the former structure looked healthy, and did not bulge into the trephine hole—pus welled up, and the child survived for a week. Post-mortem: an abscess 2 inches long, and still containing an ounce of purulent fluid, was found in the right frontal lobe; the abscess had burst externally, causing purulent meningitis.

† *Trans. Amer. Surg. Assoc.*, vol. ii. p. 78.

The needle should be kept as a guide till the abscess-cavity is definitely opened either by inserting a pair of Lister's sinus-forceps, or a sharp straight bistoury. From an experience of three cases, I have not found it as easy to get a drainage-tube securely into the abscess-cavity as it is to find this (p. 200). The abscess-cavity may be washed out with bichloride solution of 1 in 2000, or one of boracic acid; all the fluid injected should be withdrawn.

The following cases of cerebral abscess, in addition to those given at p. 161, and in the foot-notes to p. 181, are good instances of the disease and also of its successful treatment:—

A labourer,* aged sixty, was admitted into the Middlesex Hospital, under the care of Mr. Hulke, a fortnight after being struck a glancing blow on the right temple by a falling ladder, which stunned him for a few minutes and caused a considerable bruise. He continued, nevertheless, to work as usual until the middle of the third day, when headache, which he had had from the time of the accident, became very severe—so severe that his wife feared he would go out of his mind. When taken into the hospital the pulse was 56, and the temperature slightly below the normal. His mind was unclouded. About one week later, in the night, he became insensible, and in the morning the right upper and lower limbs were found absolutely palsied as regards motion, and nearly so as regards sensation. When the arm or thigh were severely pinched, he gave scarce any sign of consciousness of it, but shrank slightly when the left limbs were pinched similarly. Two days later, spastic rigidity of the left arm supervened. A small disc of bone cut out beneath the bruised bone on the right temple appeared uninjured. The dura mater bulged up so tensely that pulsation could neither be seen nor felt; its exposed surface appeared healthy. A needle connected with an exhausting syringe was pushed through it to a depth of 1¼ inch. A brownish turbid fluid rose up into the receiver, and continued to flow after the needle was withdrawn. The minute opening was enlarged with a scalpel, and a considerable quantity of fluid escaped. The flaps, which had been reflected, were replaced, and the wound was very lightly dressed with a little boric charpie. An hour later he asked for food. Next morning the spastic rigidity of the left arm had gone. On the second day slight return of power was noticed in the right limbs, and before the end of a week their palsy had disappeared. For a very few days after the operation the charpie was wetted and discoloured by the fluid which continued to ooze, but the wound soon healed, and two months after the operation the patient appeared quite well.

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* Hulke, *Syst. of Surg.*, vol. i. p. 628.

It is interesting to note in the following case* that the hemiplegia which followed the operation was only transitory. It also shows that grave symptoms may be latent for as long as five months if a skull wound remains unhealed.

A child, aged four and a half, had sustained a severe compound fracture of the right frontal bone. The removal of some necrosed portions of bone led subsequently to some slight hernia cerebri. A sinus persisted, but the child seemed well in other respects, until about five months after the accident, when left-sided convulsions (chiefly of the muscles of face and arm) came on, and an alarming condition rapidly developed. The sinus was opened up and a director passed for a distance of 1 inch into the right frontal lobe downwards and backwards. A free flow of fetid pus occurred, and after the cavity had been washed out with carbolic solution (1 in 40), a drainage-tube was inserted. The latter was removed at the end of a fortnight. Left hemiplegia followed the operation, but it passed off some twenty-four hours subsequently. Recovery was rapid and complete.

TREPHINING FOR EPILEPSY AND OTHER LATER RESULTS OF A CRANIAL INJURY.†

Indications.—Much information on this subject is given in an excellent paper by Mr. Walsham (*St. Barth. Hosp. Repts.*, vol. xix. p. 127), from which the following five headings are taken :—

i. Local indications calling for trephining.—In 44 out of 82 cases the scar or spot was painful, tender, and sensitive. Pressure in some cases caused vertigo, convulsive fits, rigidity, or spasmodic twitchings of some group of muscles. In 8 there was a fistula leading down to bare bone. In 3 a fissure existed.

ii. Cause, nature, and situation of the head-lesion to which the epilepsy was ascribed.—In 72 out of 82 cases there was a distinct history of some lesion to the head. In 46 out of the 72 there was a fracture, which in 26 of the 46 was compound and depressed.* The exact seat of the lesion is not given accurately in a large majority of the cases. In 45 it was over one or other parietal, in 14 over the frontal, in 3 over the occipital area.

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* Briefly reported from the Australian *Medical Gazette* in the *Ann. of Surg.*, February 1887, p. 143.

† Under this head are included, convulsive movements, paralysis, aphasia, idiocy, mania, and strange alterations in character and temper. The character of the fit, the frequency with which such accidents as tongue-biting occur, the tendency of the fit to be brought on by eating, and thus to cause choking, must be taken into due account when the need of an operation is being considered.

iii. Time of onset, duration, and character of symptoms.—The time at which the epilepsy followed the injury varied greatly. In the majority this took place after a variable period, even as much as 13 years. The shortest period was within a few hours.

The duration of the epilepsy, when this was established, varied from a few days to 20 years. In nearly all the long-standing cases the fits increased in severity, the intervals growing less.

In a large majority of cases, in addition to the fits, loss of memory, moroseness, delusions, even utter imbecility, or violent madness, constant headache, paralysis, presented themselves.

iv. Condition of the parts found at the operation.—In two-thirds of the cases the bone was found either depressed or variously altered or diseased. Thus it was thickened, spongy, carious, necrosed, a fistula often co-existing in the two latter. Depression, when present, often took the shape of a spiculum.†

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* In a case of Mr. West's, brought before the Medico-Chirurgical Society (*Lancet*, 1879, vol. ii. p. 798), in which epileptic fits followed on a fracture of the skull, complete relief was given by trephining, though the fracture was found to involve only the outer table; the child, who before was fatuous, aphasic, and passing her excreta involuntarily, is stated to have recovered entirely. Here the epilepsy must have been due to reflex irritation, following a fracture of the outer table, and not to any direct pressure on the brain or its membranes.

† The term exostosis is sometimes applied to the depressed bone; this, when circumscribed and osteophytic, is easily dealt with. An allied condition, rarer, and one much more difficult to deal with, is described by Dr. Echeverria (*Arch. Gén. de Méd.*, 1878, t. ii. p. 533). A conical, irregular projection of bone, measuring 2 × 2½ inches, here compressed the dura mater and brain, being situated very close to the superior longitudinal sinus, just to the left of the occipital protuberance. In trephining, the crown entered into this exostosis, the removal of it proving most laborious, the operation lasting three and a half hours. The patient recovered. A case of Kochler's, of Berlin (*Deutsch. Med. Woch.*, No. 46, 1889), bears strongly on the remarks I have made at p. 156 on the need of a more frequent use of the trephine. A sword cut had injured the bone, without depression. Epileptic fits followed in six weeks. About a year later trephining was successfully performed. The dura mater was adherent, the bone much thickened and covered with thorn-like processes pressing on, but not perforating, the dura. To this exostosis several pieces of the inner table adhered, and had pushed the dura deeply into one of the fissures. Good illustrations of a blunt spiculum of the internal table are given by Dr. Williamson and Mr. Jones (*Brit. Med. Journ.*, 1889, vol. ii. p. 919). The occurrence of the fits here two years after the injury was perhaps attributable to much stooping. Seven months after the operation the fits recurred; an open sinus which had persisted

The dura mater in the greater number of cases was healthy, but in some congested, thickened, vascular, or adherent.*

In 16 cases nothing was found at the operation to account for the epilepsy.† 10 of these 16 recovered, and 7 were cured. It is difficult to say how the trephining cured in these cases; the symptoms had lasted many years, and yet ceased after the operation. In one case, though nothing was found at the operation, a spiculum was found at the post-mortem examination not far from the trephine-hole, thus pointing to the advisability of sweeping a probe, carefully and with aseptic precautions, around the circumference of the trephine-opening, and at some distance from it.

v. Results of operation.—These are eminently satisfactory. Out of 82, 48 were completely cured, and 13 relieved. Of the latter, some may have been quite cured after a longer interval, and, on the other hand, some of the former may have relapsed.

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being explored, a small spicule of necrosed bone "projecting downwards" was removed. Up to the last report recovery was complete.

* A rare condition (Echeverria, *loc. supra cit.*, p. 535) was as follows:—The patient, aged twenty-two, had, ten years before, fractured his right parietal bone. Epileptic fits began six months after the injury, and their increasing frequency was associated with an extreme degree of idiocy, the patient being, on admission, a mere automaton, without intelligence or memory. On the seat of fracture being explored, a kind of pouch was found embracing an old blood clot. When this was turned out, the hæmorrhage was so free as to require the actual cautery. The intellectual faculties were largely restored by the operation, and the fits were also much reduced in frequency. The death of the patient took place, nearly nine months later, from meningitis, apparently due to exposure to the sun. An autopsy showed that the clot-containing cavity was in connection with the brain-membranes, and apparently continuous with one of the branches of the middle meningeal artery. In some cases a cyst may underlie the seat of injury, and be the cause of the mischief. Thus (*Ann. of Surg.*, vol. iii. No. 6, p. 522; *Amer. Journ. Med. Sci.*, April 1886), there is the case of a pistol-shot wound of the skull, about $\frac{3}{8}$ inch from the middle line, and $1\frac{3}{8}$ inch from the hairy scalp, followed by aberration culminating in marked insanity. The depression in the forehead being explored by a crucial incision, an opening in the skull was discovered, closed by fibrous material. In the expectation of finding an abscess-cavity, the needle of a hypodermic syringe was thrust through here in several directions until the barrel was found to be filling with a serous fluid, all of which was withdrawn to the extent of about 2 drachms. On emerging from the anæsthetic, the patient was found to have fully regained his mental equilibrium, in which condition he remained five months later, the wound having promptly healed.

† In two of them nothing was found, even after a post-mortem examination. In a case under the care of Dr. Bennett and Mr. Gould (*Brit. Med. Journ.*, 1887, vol. i. p. 12), in which violent and frequently repeated fits lasting six years were entirely arrested by trephining over the seat of injury, nothing was found in the bone, dura mater, or brain to explain the fits, or the good result.

Operation.[*]—To begin with, a painful cicatrix[†] may be freely excised. This may be done with good hope that nothing further in the way of operation will be required in cases where the scar is constantly painful, tender, or hot; where it corresponds to the course of some known nerve, and in any case where the original wound was lacerated, or contused, and slow in healing, and where there is any chance of a splinter of wood or metal being embedded in the scar.[‡]

If it be necessary, as it usually is, to remove a crown of bone, appropriate flaps of one of the different forms mentioned at p. 163 must be reflected with the aseptic and other precautions already given. Hæmorrhage being arrested, and the flaps retracted by Spencer Wells' forceps, the pericranium is carefully divided and turned off the bone,[§] and its condition noted as to thickening and other evidence of old inflammation. The bone being thoroughly exposed, the surgeon must be prepared for the following conditions—viz., the line of an old fracture, necrosis (indicated by a sinus with prominent granulations), hypertrophic sclerosis amounting, in some cases, to eburnation, and, on the under surface, depressed fragments of the internal table, spurs, or nodules of bone. Any sequestrum will of course be removed. If the surgeon finds it needful to resort to trephining, he will do so with the precautions given at p. 165, remembering that here he is especially likely to be dealing with a crown of bone of varying density at different points of its circumference.[‖] It must be elevated with particular caution, as a spicule may have made its way through the dura mater and be pressing on the brain.*

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[*] During this, the surgeon must be on his guard for the sudden supervention of epileptic seizures or convulsive movements of one limb—*e.g.*, when he is raising a crown of bone much thickened and adherent to the dura mater.

[†] Prof. Briggs (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 116), in a most excellent paper, in which large personal experience throws much light upon the subject, speaks of having had five such cases. After thorough removal of the scar, the wound was left to heal by granulation; in all the attacks were arrested. In one of Dr. Echeverria's cases (*loc. supra cit.*), convulsions, vertigo, &c., were cured by the removal of a small fibroma adherent to the frontal periosteum and supra-orbital nerve.

[‡] Dr. Johnson (*Clin. Soc. Trans.*, vol. vi. p. 35) records a case where trismus facial neuralgia, and paralysis, with a recurrence of epilepsy (the patient, aged forty-four, had been free from fits for twelve years), were caused by a sharp angular piece of flint, embedded in a painful cicatrix of the cheek, the remova of which was followed by complete recovery.

[§] Or this structure may be raised together with the flaps.

[‖] Free and most embarrassing hæmorrhage may be met with in sawing through altered diploë traversed by large sinus-like venous channels, requiring sponge pressure before and after the operation.

If the first crown shows nothing abnormal, a probe should be gently inserted between the bone and dura mater and carefully swept around, so as to give information of the condition of the inner surface of the surrounding bone. If the first crown show changes which are, however, not localized to it, the trephine must be applied again till all thickened bone capable of exerting pressure on the brain and its membranes is removed.†

If no change can be found in the crown removed, or in the surrounding bone, what more should be done on this occasion? If there be reason to suspect abscess in the brain, because the symptoms of this condition (pp. 181, 197) are present, or because the dura mater bulges up without pulsation ‡ into the trephine-hole, the treatment should be as directed at p. 183.

Prof. Horsley, in one of his brilliant cases lately published,§ has shown how much it may be possible to do in cases of epilepsy where the bone has already been removed, and where the mischief lies deeper down.

A patient, aged seven, was run over by a cab and sustained a depressed, comminuted fracture, with loss of brain-substance in the situation mentioned below. The fragments of bone were removed, and the wound ultimately healed, although it suppurated freely, and hernia cerebri occurred. The patient was hemiplegic for some time, but gradually (in seven weeks) the paralysis disappeared. When aged fifteen, the patient began having fits, which were very intermittent. When aged twenty-two, he was admitted into the National Hospital for Paralysis and Epilepsy; he now had an enormous number of fits, and for some days was in the status epilepticus. On the left side of the vertex (the exact site, as determined by measurement, being the centre of the upper third of the ascending frontal convolution—that is, posterior to the hinder end of the superior frontal sulcus) there was a quadradiate scar, opposite to the centre of which the bone could be felt to be wanting, so as to form an oval opening in the skull, the long diameter of which was about an inch, and parallel to the sagittal suture. Pressure on this scar always gave pain, which was very greatly increased when the patient was suffering from one of his paroxysms of fits.

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* In one case Prof. Briggs (*loc. supra cit.*, p. 106), on elevating the bone, found that a spicule of bone from its under surface had penetrated the superior longitudinal sinus. The hæmorrhage was arrested by sponge-pressure, and the patient made a good recovery. In such a case, the sponge should be carefully disinfected and dusted with iodoform (p. 158).

† Prof. Briggs (*loc. supra cit.*, p. 118), speaking of one case in his practice, says that six large crowns of the trephine were found necessary to surround and separate the thickened and roughened bone, which, after the angles were rounded off with a Hey's saw, left an opening as large as the palm of the hand. The patient was cured.

‡ In a case of Dr. Oliver's (*Lancet*, 1887, vol. ii. p. 1183), the dura mater pressed up tensely through the wound. An incision was followed by a few teaspoonfuls of serum containing shreds of fibrin. For a day after serum continued to escape, amounting to about 2 or 3 ounces.

§ *Brit. Med. Journ.*, 1886, vol. ii. p. 672.

The fits, which occurred in batches (at this time the patient had 3000 in a fortnight), were almost always of the same character, usually commencing in the right lower limb, sometimes in both the right limbs simultaneously. An example of a fit of the first category is as follows:—

The right lower limb was tonically extended, and the seat of clonic spasm. The right upper limb was then extended at right angles to the body, the wrist and fingers being flexed; the fingers next became extended, and clonic spasms of flexion and extension affected the whole limb, the elbow being gradually flexed. The spasms in the lower limb having ceased, while those in the upper one continued vigorously, spasm gradually affected the right angle of the mouth, then the right side of the face, and followed by turning of the head and eyes to the right.

To sum up:—The focus of discharge lay around the posterior end of the superior frontal sulcus, this point coinciding, as mentioned above, with that found by actual measurement. The patient was distinctly hemiplegic, even ten days after the last fit, but he could perform all the movements of the right limbs, though about half as strongly as on the left side; there was no affection of sensation on the right side, while the reflexes, superficial and deep, were exaggerated in both the right limbs.

The bone around the old opening was freely removed, the dura mater, arachnoid, and skin being found to form a homogeneous mass of fibrous tissue, the former being raised with the flap. The scar in the brain was found to be highly vascular, of a deep-red colour, and about 3 centimetres long and 2 broad. The membrane covering the brain around appeared to be very opaque, and the brain of a slightly yellower tinge than usual. The scar and about ½ centimetre of surrounding brain substance was excised to the depth of 2 centimetres. It was then found that the scar penetrated a few millimetres farther into the corona radiata fibres of the marginal convolution. This portion was then removed, and the wound closed. Three fair-sized veins, coming from the middle of the area of the upper limb, had to be ligatured, since they passed directly into the scar. The wound completely healed in a week. The tension of serum was twice relieved (p. 248).

The most interesting point now to be recorded is, that, after the operation, the patient was at first completely paralysed in the digits of the right upper limb; and for further flexion of the wrist and supination of the forearm. Coupled with this motor paralysis, there was loss of tactile sensibility over the dorsum of the two distal phalanges of the fingers. He could not localize the touch anywhere below the wrist within the distance of one internode; finally, he could not tell the position of any of the joints of the digits. We have here, apparently, a distinct instance of loss of tactile sensibility and muscular sense, coupled with motor paralysis, all due to lesion* of the cortex. This condition of motor and sensory paralysis gradually disappeared in the course of the next two months. Up to the time of Prof. Horsley reading his paper in August 1886 the patient had had no fits.

Most strict antiseptic precautions† (p. 241) should be made use of before and during the operation, sufficient drainage should be provided, and, in bringing the flaps together, the drainage-tube must not be pressed upon or closed. Great care must be taken to keep the wound sweet later on, putrefaction leading to septic softening and hernia of the brain. If it has been needful to remove much bone, some of this should be preserved and replaced with the precautions given at p. 167. If a single crown is replaced, as in Mr. Clark's case, p. 167, his advice to first bevel and thin it off, so as to allow for drainage and prevent pressure on the dura mater, should be followed.

Causes of Failure after Trephining for Traumatic Epilepsy.—Amongst these are:—

1. Not hitting off the right spot.—A bony spiculum, undetected at the operation, has been found, post-mortem, not far from the trephine-hole (p. 186). To meet this contingency, it has been advised to sweep a probe carefully round the circumference of the trephine-hole, and at some distance from it.

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* By this, Prof. Horsley means the disturbance in the area for the upper limb produced by the ligature of the veins coming from it. He points out, however, that it is very possible that some of the fibres coming from the gyrus fornicatus in the corona radiata may have been injured.

† Dr. Billings (*Amer. Journ. Med. Sci.*, July 1861) has collected 72 cases of epilepsy trephined, with a mortality of 16. In proof of the importance of these, Dr. J. Russell (*Brit. Med. Journ.*, 1865, vol. i. p. 582) gives 80 cases with 44 recoveries, while more recently Dr. Briggs (*loc. supra cit.*) has trephined 28 cases of epilepsy with only 1 death.

2. A general * and diffuse thickening of the bone round the site of injury (*vide* p. 189, and foot-note).

3. Owing to the long continuance or to the amount of the irritation, the brain may be permanently affected. Thus, in words already quoted (p. 156), there are cases of depressed fracture in which "the constant irritation has begotten a permanent impression upon the brain and nervous system which remains after the offending point of bone has been removed." The grosser and more localized the lesion, the more speedy will be the relief as long as the fits are diminished in number and severity, the prognosis still hopeful, though they may be very slow in disappearing. The supervention of insanity is, of course, very grave.

4. Idiocy or mental weakness persisting.—From alterations in the membranes or brain itself too extensive for removal.

5. Neglect of after-treatment, both medical and surgical, but chiefly the former.—Prof. Nancrede's words † are worthy of remembrance:—"The operation, indeed, removes the most important cause of the epilepsy, but only one cause. The disturbed circulation in the nervous centres, and the excessive mobility of the nervous system, can only disappear with time, and if all other sources of peripheral irritation are not most carefully guarded against, the patient may be slightly, if at all, benefited, whereas judicious after-treatment will sometimes relieve an apparent operative failure."

6. Trephining for fits not epileptic in character.—Mr. Hulke ‡ gives a most interesting account of a case in which he trephined for "anomalous" convulsive attacks supervening several months after a head injury. The operation, while it did no harm, was useless. Bromide and iodide of potassium having been tried in vain, a full trial of valerianate of zinc was made, the fits subsiding under this treatment. This fact, the way in which the fits came on, the slight degree of unconsciousness, its gradual onset, and the fact that occasionally the first convulsion had the aspect of

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* Nothing but a general thickening of the bone was found in a case of Mr. Clark's (*Lancet*, 1886, vol. i. p. 243). The cure was ultimately complete, though tardy.

† *Loc. supra cit.*, p. 102.

‡ *Med. Times and Gaz.*, 1881, vol. ii. p. 85. It is noteworthy that the bone removed, and the dura mater in this case being normal, an aspirator-needle was pushed through the latter to the depth of an inch, and then withdrawn, as nothing escaped through it. For a few minutes, owing to the high intra-cranial pressure, cerebro-spinal fluid spirted in a slender stream for the distance of nearly a foot, and continued to leak away for several hours.

purposive movement, supported the view that the fits were not epileptic, but hysterical, induced by the shock of an accident in a person of unstable nervous system. On the other hand, the traumatic origin, the headache, the darting pain on touching the part injured, were all suggestive of some chronic irritative process, and justified the operation of trephining.

7. A septic condition of the wound, almost invariably the fault of the surgeon, and bringing about (1) meningitis, (2) hernia cerebri, (3) cerebral abscess.

Finally, in cases of doubt, and where the operation has failed, the interference of the surgeon will be justified by the fact that traumatic epilepsy tends to grow worse, and is little affected by medical treatment. In the words of Echeverria (*loc. supra cit.*, p. 551), once declared, traumatic epilepsy caused by injury to the head leads to early insanity or to feebleness of intellect.

Accidents during the Operation.—Perhaps the fault of the surgeon—viz., (1) middle meningeal hæmorrhage, (2) hæmorrhage from an opened sinus (p. 158).

TREPHINING FOR MASTOID ABSCESS AND CEREBRAL ABSCESS, THE RESULTS OF OTITIS MEDIA

(Figs. 50 and 51).

Points of Practical Importance to the Surgeon in the Anatomy of the Parts concerned.*

I. *Tympanum.*—(*a*) Roof always thin, not more than a line and a half in thickness, often thinner.† Through this inflammation in otitis media readily reaches the brain, causing meningitis, subdural or cerebral abscess. (*b*) Parts of the brain and cerebellum which are in contact with middle ear. These are the middle and back part of the temporo-sphenoidal lobe, and the outer and front part of the lateral lobe of the cerebellum. With regard to this latter site of abscess, Mr. Toynbee‡ held that the greater frequency in adults of cerebellar abscess and, with this, thrombosis of the lateral sinus were due to the development of the mastoid cells backwards. (*c*) The mucous membrane and the endosteum lining the tympanum are in most intimate contact; hence, in otitis media, caries and necrosis readily occur, especially if the blood-supply to the tympanum from the dura mater is cut off. (*d*) The skin of the external auditory meatus is continuous with the membrana tympani, and thus otitis media may be set up from without, as well as by mischief reaching the tympanum through (*e*) the Eustachian tube, which enters in front, and makes the mucous membrane of the throat continuous with that of the tympanum. (*f*) The outlets of the mastoid cells and of the tympanum are inadequate for drainage in otorrhœa, as many of the mastoid cells lie below the level of their opening into the tympanum, and the floor of the tympanum is, in part, below the orifice of the Eustachian tube. The result is that decomposition is thus favoured.

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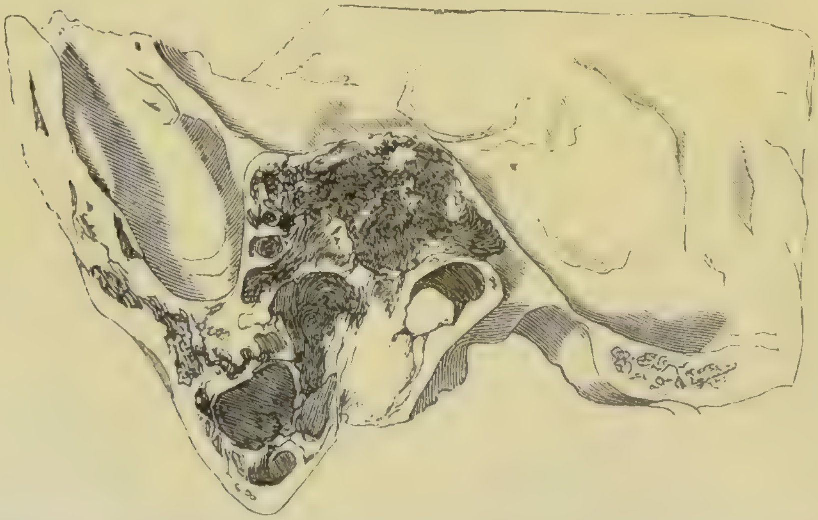
* These should be studied together with a skull and one or two sections of a temporal bone, somewhat similar to that shown in Fig. 50.

† The bony roof is occasionally absent.

‡ See Fig. 50.

II. *Mastoid Cells.*—(*a*) Their development varies with age. In adults, if well marked, they may measure 1½ inch horizontally, 2 inches vertically, and reach quite up to, and even around, the lateral sinus (Fig. 50). (*b*) Two groups of cells are present: (1) The horizontal, which are closely adjacent to the back of the tympanum, and communicate with it. This group constitutes "the antrum," and is present both in early and late life. Their size is that of a good-sized round pea. The antrum is bounded externally by that part of the squamous bone which is immediately behind and above the external meatus. Through this bone, extremely thin in early life, pus from the tympanum may make its way externally. After the second year it becomes much thicker, and this mode of exit is cut off. It is through this bone that the trephine or drill should be directed in opening up the mastoid cells. (2) The vertical. These are not developed in earlier life;

FIG. 50.



A section of a temporal bone showing the mastoid cells, both horizontal and vertical, with the close proximity of the lateral sinus. (Toynbee.)

later on their presence brings pus nearer the lateral sinus and cerebellum (*vide supra*). (*c*) The contents of the cells vary a good deal, being in some air, in others marrow. In yet a third class the cells are largely obliterated by old sclerosing ostitis. (*d*) The passage of veins from the tympanum and mastoid cells. These fall into three chief groups: (1) those opening into the lateral sinus; (2) those passing through the mastoid foramen into the occipital vein and the soft parts outside the skull; (3) those running through the petro-squamosal suture to the dura mater. All these veins carry sheaths of connective tissue, and thus inflammatory products may reach (*a*) the lateral sinus, causing septic phlebitis; (*b*) the soft parts outside, causing periostitis, cellulitis, &c.; (*c*) the dura mater and brain, causing meningitis and abscess.

FOUR RESULTS OF OTITIS MEDIA WHICH MAY COME UNDER THE NOTICE OF THE SURGEON.—(i.) Acute inflammation of mastoid cells: mastoid abscess; (ii.) abscess in brain or cerebellum; (iii.) septic thrombosis of sinuses and pyæmia; (iv.) meningitis. N.B.—The above four often co-exist, and thus the symptoms may be much blended together and confusing.

(i.) ACUTE INFLAMMATION OF MASTOID CELLS: MASTOID ABSCESS. —*Symptoms.*—These vary much. The more the periosteum over the mastoid process is involved, the more clear are the symptoms and the more certain will be the relief from a sufficient incision. The less the periosteum and the soft parts are involved, or the more altered the bone by old sclerosing ostitis due to prolonged irritation, the less evident and decided are the symptoms, and the less likely is an incision to relieve.

Indications for interfering by Incision or Trephining.—History of old otitis media,* with long-continued discharge and deafness. The discharge may have ceased owing to a plug of caseous pus or granulations, or increased owing to some blow, exposure to cold, use of instruments, or some independent pyrexia. Pain in and behind the ear, over the temple or occiput, unrelieved by ice, leeches, fomentations, &c. Mastoid tenderness, swelling, redness, œdema. N.B.—The last three are by no means always present in mastoid abscess. Discharge fetid, and unrelieved by washing out every hour with lotions, *e.g.*, mercury perchloride (1 in 2000), saturated boracic acid, &c., followed by the insufflation of powders,

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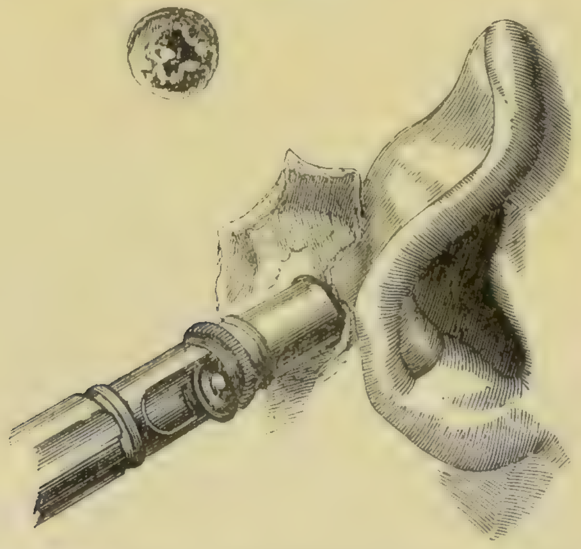
* Mr. Barker drew attention to the much greater gravity of old-standing cases. Thus otorrhœa does not cause cerebral abscess till it has lasted months or years. In only two of the cases which Dr. Pitt collected in his Gulstonian Lectures, 1890, was the duration of the otorrhœa under a year.

e.g., boracic acid, finely powdered, 3 parts, iodoform 1 part. Drowsiness, torpor, but absence of the graver symptoms, pointing to cerebral abscess, pyæmia, or meningitis (pp. 182, 197).

Wilde's Incision.—The parts being shaved and cleansed, and an anæsthetic cautiously given, a free incision is made with a strong-backed scalpel down to the bone from the base to the apex of the mastoid process, ½ inch behind the auricle. The condition of the periosteum is then noted; if it is not much softened, if there is no marked escape of pus, &c., the bone must be investigated. If any soft, carious, or bare spot is found, the cells must be opened up with a drill, bradawl, gouge, or trephine. All caseous pus and foul granulation-material must be removed with a sharp spoon, syringing, &c. A short drainage-tube is then inserted, or one passed between the antrum and external auditory meatus, if possible.

FIG. 51.



Trephining the mastoid cells. The auricle is drawn forwards. The direction of the trephine is too much upwards. Above is shown the under surface of the disc of bone removed, with the cells opened.

Trephining Mastoid Cells.—If on exploration the bone is not altered, or if the above incision does not relieve, the cells must be freely opened up by trephining. The above incision, if present, is converted into a ⊤ above, or a crucial one made, and a small trephine applied immediately behind the auricle (Fig. 51), on a level with the external auditory meatus, and directed forwards and inwards, especially in children, owing to the close proximity of the lateral sinus. After sawing for ¼ or ½ inch, the crown removed will be found to have penetrated the cells. These are then to be freely opened up with a gouge, cleansed as far as possible, and disinfected as explained above. As good a dressing as any to apply afterwards is lint wrung out of saturated boracic-acid lotion, kept moist, and frequently renewed, iodoform being dusted on occasionally, and the middle ear frequently cleansed as already directed. The bowels should be freely opened, and limited, light diet given at first.

I much prefer, for opening up the mastoid cells, a small trephine (with $\frac{1}{4}$-inch crown) to any of the various drills. Save in early life, the cells are somewhat complicated, their contents often most fetid, and a thorough opening up is urgently required. This, it seems to me, is most thoroughly and speedily done by a small trephine applied and directed as advised. In 13 cases of mastoid trephining I have never seen the least danger from the use of the trephine, if it be directed properly. A small gouge is also efficient, especially when there is a softened spot in the bone. It is, of course, to be preferred to the trephine in enlarging an opening, *e.g.*, towards the lateral sinus.

Hæmorrhage during and after the operation* is occasionally troublesome, especially when the tissues are soft and almost rotten, and ligatures difficult to apply. Such hæmorrhage is best met by forcipressure, made use of with Spencer Wells' forceps. Thus, in one case, after successful opening of the mastoid cells, in a patient admitted with erysipelas of the scalp and mastoid abscess, secondary hæmorrhage took place from the posterior auricular artery. The tissues not holding a ligature, and breaking away with torsion, I applied a pair of the above-named forceps. When they came away on the fifth day no further hæmorrhage had taken place, and the case made a good recovery.

(ii.) ABSCESS IN THE BRAIN OR CEREBELLUM.—(A) When in the brain, the collection of pus is usually in the middle and back part of the temporo-sphenoidal lobe; (B) when in the cerebellum, in the front and outer part of the lateral lobe.

Symptoms.—These are often rather negative, no special nerve symptoms being called out in the above regions, as is the case with an abscess in the motor area. There is a history, perhaps, of mastoid suppuration, with the symptoms given above, unrelieved by treatment. A latent period, in which headache, vomiting, and a dull, heavy mental state are usually present, is followed by a more urgent stage. Amongst the most important symptoms of this are agonizing headache;* drowsiness, deepening into coma; while power of speech remains, the answers are unwillingly given, delayed, but intelligent; "sluggish, but perfect cerebration" (Barker, *Lancet*, 1887, vol. i. p. 1177); vomiting (this is occasional, or ceases after a day or two), not constant and incessant; one or two rigors may occur at the commencement of the abscess-formation, but they are not commonly repeated in an uncomplicated case of abscess; the temperature is rarely high in cases uncomplicated with meningitis or thrombosis, often subnormal—*e.g.*, 97°, and falling; the pulse slow—*e.g.*, 65–50; optic neuritis;† progressive emaciation; obstinate constipation. Hemiplegia,‡ paralysis of face, ptosis, alteration of pupil, are either absent or present only later on. The following symptoms are most grave, and point to a fatal termination being not long delayed—viz., lividity, irregular pulse, tracheal râles, pulmonary crepitation, incontinence of excreta, tremors, and cervical swelling along the internal jugular vein (p. 202), and, of course, evidence of pyæmia or meningitis, these conditions often co-existing.

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* If the lateral sinus has been accidentally opened, and is healthy, the treatment must be that given at p. 158. This complication is, however, a serious one, owing to the difficulty of keeping the wound sweet, and thus of preventing septic phlebitis.

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* Dr. Pitt (*loc. supra cit.*) considers that the two most characteristic symptoms are "a headache of intense severity, and a dull, sluggish mental state."

† It seems at present unsettled to what condition, thrombosis, meningitis, &c., this symptom is chiefly due. Thus, Dr. Pitt (*loc. supra cit.*, lect. i.) holds that well-marked optic neuritis is more suggestive of sinus thrombosis than of other lesions; further, that it is unfrequent in cerebral abscess, and is often in such cases due to a complication. Messrs. Lawford and Edwards (*Ophth. Soc. Trans.*, vols. iii., iv., v., and vii.) believe that in all cases of optic neuritis of intra-cranial origin, the affection of the optic nerves is due to an extension of inflammation to their sheaths from inflamed pia mater, and that, therefore, optic neuritis in these cases is diagnostic of basal meningitis. Mr. Ballance (*Lancet*, 1890, vol. i. p. 1116) is of opinion that optic neuritis "points to the fact that the dura is already sloughed, or is involved in inflammation sufficient to produce slight basal meningitis as far forward as the optic nerve." For my own part, I do not think we are yet in a position to draw conclusions as to this point and several others usually given as indicative of cerebral abscess. While optic neuritis is certainly met with in abscess, meningitis, and thrombosis, it may be present in mastoid inflammation without any cerebral abscess or other known complication save otitis media, and may persist for a long time after the case has been successfully treated by trephining; this occurred very markedly in a case which I was asked to trephine by Dr. F. Taylor in his wards at Guy's Hospital. Another point is, I think, certain—that if optic neuritis persists after a cerebral abscess has been opened, and all seems to be doing well, it is evidence that the cavity is not completely drained. Persistence of the neuritis was a very marked feature in the case mentioned later, in which, after trephining and finding a very large temporo-sphenoidal abscess, I had on two later occasions, many weeks after, to let out re-collections of pus. Here it was not until long after the first operation, the wound being now healed, and the patient for some time up and about to leave the hospital, that Dr. Goodall, the medical registrar, reported "On Aug. 2 (five and a half months after the first operation) there was a little indistinctness of the inner edge of the right disc (the abscess had been on the left side), otherwise both discs were normal."

‡ I should look upon this as of grave omen, and indicating that the abscess has either burst or is about to do so into the lateral ventricle.

Treatment.—Early aseptic trephining: sites (A) *In the Brain.*—Mr. Barker (*Brit. Med. Journ.*, December 11, 1886) thinks that nine-tenths of abscesses in the brain lie within a circle with a ¾-inch radius, whose centre lies 1¼ inch above, and the same distance behind, the centre of the bony meatus.* This corresponds to the posterior inferior angle of the parietal bone, and the lower and back part of the temporo-sphenoidal lobe. Dr. Pitt (*loc. supra cit.*, lect. i.) thinks that the area under which temporo-sphenoidal abscesses will almost universally be found may be said to be bounded anteriorly and posteriorly by curved lines drawn through the temporo-maxillary joint and the middle of the mastoid, running at right angles to the sagittal suture, and lying between ½ inch to 2 inches above the meatus. The lower part of this area should be explored.

(B) *In the Cerebellum.*—Mr. Hulke (*Lancet*, July 3, 1886) found a cerebellar abscess by trephining just below the inferior curved line, 2 centimetres behind the mastoid process. Mr. Barker advises a point 1½ inch behind the centre of the meatus and 1 inch below the base line (a line running from the lower border of the orbit backwards through the centre of the meatus—Reid). This point is well below the vertical and well behind the horizontal part of the lateral sinus, while it gives easy access to all the anterior third of the lateral lobe, in which the pus is invariably found.

Owing to the far greater frequency of temporo-sphenoidal abscess, most of the above remarks apply to the treatment of cerebral abscess. While many of the symptoms given at p. 197 are common to cerebral and cerebellar abscess, it is possible that the following may help in distinguishing the two. Dr. McBride (*Edin. Med. Journ.*, 1887, vol. i. p. 996), having found that, when the labyrinth is diseased, the abscess forms oftener in the cerebellum than in the temporo-sphenoidal lobe, thinks that, if the conduction of sound by bone is impaired, it is probable that the abscess is in the cerebellum. Dr. Edgeworth (*Bristol Med. Chir. Journ.*, June 1890) thinks that in slowly enlarging, uncomplicated cerebellar abscess reeling gait and vertigo, (from pressure on the middle lobe) and tenderness on percussion over the cerebellum will be helpful in diagnosis.

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* *Man. of Surg. Operations*, p. 400. In children I think it wiser to keep nearer to the ear—*i.e.*, to place the trephine no further than an inch behind and the same distance above the meatus. Otherwise there is danger of opening the lateral sinus.

Steps of the Operation of Trephining for Brain Abscess in Connection with Otitis Media.—The tympanum and mastoid cells being rendered as aseptic as possible, the head is shaved, and an anæsthetic cautiously given (p. 163).

A semilunar flap being turned up, and hæmorrhage arrested by applying Spencer Wells' forceps, a ½-inch trephine is applied over the spot selected (according as the pus is believed to be in the temporo-sphenoidal lobe, or in the cerebellum), and worked cautiously, owing to the thinness of the bone in these regions. The crown removed should not show any of the groove for the lateral sinus, nor, if possible, any middle meningeal branch. If the latter is in the way, crossing the dura mater, it should be secured with two ligatures, or the opening in the bone enlarged. The dura mater being next divided, a little arachnoid fluid may escape, and the brain, which bulges forwards, without pulsation may show lymph upon its surface, and yet the case end successfully if the pus is evacuated. A fine trocar, or aspirator needle (without making any vacuum), is next slowly inserted either straight in, or in a direction downwards, forwards, and inwards towards the apex of the petrous bone. If the abscess is struck, bubbling of foul gas or a few drachms of pus (usually foul) [*] will escape when the needle has entered to a depth of ½ or ¾ of an inch. The puncture is then enlarged with a straight bistoury or a Lister's sinus-forceps, and the abscess-cavity syringed out with boracic-acid lotion. A short drainage-tube should be inserted into this cavity, stitched to the flap, and this so arranged as not to interfere with free drainage.[†] In three cases in which I followed Mr. Barker's directions for temporo-sphenoidal abscess, a little modified for children, I had no difficulty whatever in finding the abscess, but it was by no means equally easy to feel sure that the drainage-tube was properly inserted and retained in the abscess-cavity. In one case, which ultimately made an excellent recovery, thirty-six hours after the trephining (Feb. 20) I was unable to satisfy myself that the tube, though still *in situ*, reached the abscess. As there was a great tendency to blocking of the tube, owing to the thickness of the pus and the amount of brain detritus present, it was not stitched, so as to allow of daily removal and cleansing. All did well for a fortnight, save that the temperature tended to remain sub-normal. Then headache returned, and on March 10 I inserted a scalpel along the track of the tube, giving vent to thick, green, sweet pus. A larger drainage-tube was inserted and stitched to the flap, which was partly cut away to facilitate drainage. There was the same tendency for the drainage-tube to get blocked, and a fresh collection again took place, with return of headache. On May 1 I again evacuated from 3 to 4 ounces of pus, operating now through a hernia cerebri, the size of a walnut. This was clipped away with scissors. After this third operation the patient made an excellent recovery. The hernia cerebri was cured by the constant pressure of a leaden plate notched for the drainage-tube. This was kept in place by the unremitting attention of my dresser, Mr. Turner. While soft tubes are safer for the head of a restless patient and more easily secured, in the future, when there is much tendency for the pus to block the tube, and difficulty of introduction, the use of a silver one would be safer. Mr. Barker (*loc. supra cit.*) says these may be readily fashioned out of an old silver catheter, which, after being made nearly red hot, is perfectly cleansed. The wound is then dusted with iodoform, and sal alembroth gauze or other aseptic dressings applied. Those for the mastoid trephining should be kept separate. The drainage-tube should be retained as long as any cavity exists, probably for two or three weeks, being shortened very gradually. The treatment should be rigidly aseptic, in order to secure early healing, and to prevent the risk of softening and hernia cerebri.

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[*] Broken-down brain-material must not be taken for this.

[†] Part of these should be cut away, if needful, for this purpose. Dr. Macewen (*Lancet*, 1887, vol. i. p. 616), after finding an abscess by removing a ½-inch disc 1 inch above and ½ inch behind the meatus, as there was much oozing of pus, and evidence of a considerable area of softened, pus-infiltrated brain around the abscess, made counter-drainage as follows :—An aperture was drilled just above the bony boundary of the external auditory meatus, involving the squamo-petrosal suture. The dura mater was examined here, and found intact. It was penetrated, and the abscess-cavity reached. Boracic acid was then passed from this aperture so as to wash out the abscess, and it was continued till it passed freely out by the upper opening. The current was then reversed. Drainage-tubes were placed in both apertures. The case did well.

Of the remaining three complications of otitis media, the first two have been several times attacked successfully. Mr. Barker, in his Hunterian Lectures, encourages us to hope that even the third may sometimes not be beyond the reach of surgery.

(i.) *Subdural Abscess.*—We owe our knowledge of this condition chiefly to Mr. Barker (*loc. supra cit.*) He believes that two spots are "particularly liable to this condition. The first and commonest, especially in children, is the neighbourhood of the petroso-squamosal suture above. The next and most serious is the sulcus lateralis below." Both varieties are most frequently fatal by setting up a diffuse meningitis. Opening the antrum at a point from $\frac{1}{3}$ to $\frac{1}{2}$ inch behind and the same distance above the centre of the meatus, free removal of the bone with the gouge both in the direction of the petro-squamosal suture and the lateral sinus until the dura mater is well exposed and all question as to the release of septic matter beneath it is set at rest, are the chief points in the treatment of subdural abscess (Barker).

(ii.) *Thrombosis of Sinuses.*—The following remarks refer to thrombosis of the lateral sinus. This is a grave lesion, from its tendency to cause general pyæmia and distant suppurations. Mr. Ballance (*Lancet*, 1890, vol. i. p. 1116) believes that the following group of symptoms, when present together, are pathognomonic of septic thrombosis. 1. A history of purulent discharge from the ear for a period of more than a year. 2. The sudden onset of the illness, with headache, vomiting, rigor, and pain in the affected ear. 3. An oscillating temperature. 4. Vomitings, repeated day by day. 5. A second, third, or more rigors. 6. Local œdema and tenderness over the mastoid,* or in the course of the internal jugular.† 7. Tenderness on deep pressure at the posterior border of the mastoid and below the external occipital protuberance. 8. Stiffness of the muscles of the back or side of the neck. 9. Optic neuritis.‡

The treatment of these cases must, in Mr. Ballance's words, "be twofold—viz., the free exposure and removal of the focus from which the pyæmic infection has occurred or is threatening; and, secondly, the establishment of a block in the highway, along which the infecting agents are travelling from the local focus into the general circulation."§ This is carried out by first freely opening the mastoid, allowing of the escape of extra-dural collections of pus, and removing with spoon and syringe the clot within the lateral sinus, and afterwards by placing two ligatures on the internal jugular‖ in the middle of the neck and dividing the vessel between them. There is no risk of hæmorrhage from the lateral sinus, provided there be a sufficient opening in the skull, so the trephine opening should be enlarged in the direction of the sinus, so as to give ample room for dealing with it. If a doubt exists as to the thrombosis of the sinus, a grooved needle should be inserted. If necessary, the sinus can easily be plugged or seized with ordinary artery-forceps.* The jugular having been tied,† the outer wall of the sinus should be slit up as far as the limits of the opening in the bone will allow, and as much as possible of its contents removed with sharp spoon and syringe. Constant irrigation with bichloride solution (1 in 2000) should be employed, and iodoform thoroughly used.

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* Absence of these points may be explained by sclerosing ostitis of the mastoid, and in rare instances, Mr. Ballance thinks, by absence of the occipital vein.

† Œdema or tenderness over the internal jugular are due to extension of the clotting, and phlebitis, or to enlargement of the deep lymphatic glands.

‡ This has been already spoken of, p. 198.

§ "Whenever the mastoid vein, which perforates $1\frac{1}{4}$ inch behind the meatus, and on a level with it, is found thrombosed, the sinus should be explored" (Pitt, *loc. supra cit.*).

‖ Mr. Horsley had previously (*Clin. Soc. Trans.*, vol. xix. p. 290) suggested

(iii.) *Meningitis.*—This, when diffuse, will probably always be hopeless. Mr. Barker, in his Hunterian Lectures, which have done so much to aid others in this subject, believes that a plastic localized form of meningitis is not infrequently met with in these cases, especially over the tympanum and squamous bone, or over the sulcus lateralis in the posterior fossa. In such cases as where it is spreading from the roof of the tympanum up over the temporal lobe into the Sylvian fissure, Mr. Barker thinks that free removal of bone with irrigation and drainage would save many a patient. He relates one case (*loc. supra cit.*, p. 68) in which this was very likely the case, but, owing to the patient's happy recovery, this could not be verified.

As to symptoms of meningitis, I fear we have none reliable save involvement of the cranial nerves, and, when we get such evidence as squint, the case has gone beyond interference. The frequency and meaning of optic neuritis has already been alluded to, p. 198. While headache may be as marked a feature in cerebral or cerebellar abscess as in meningitis, I am inclined to think that in the last of these it is more persistent; in the later stages of abscess it is not uncommon for the headache to remit.

OPERATIVE INTERFERENCE IN THE CASE OF FOREIGN BODIES IN THE BRAIN.

Under the above heading such bodies as bullets, knife-points, &c., are included. Depressed and isolated fragments of bone may

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ligature of this vein in these cases, and Mr. Lane (*Clin. Soc. Trans.*, vol. xxii. p. 262) had acted on this suggestion with success.

* Mr. Ballance advises not to pass a ligature round the sinus, as, in so doing, the intra-dural space is opened, and may be infected.

† If the sinus contain septic clot, the vein should be tied before this is interfered with, lest any of it be loosened and carried into the lungs (Ballance).

come within the meaning of foreign bodies, but have already been considered (p. 159).

A. *Bullets.*—The following sites,* being those in which a hospital surgeon is usually called upon to treat bullet wounds, may be briefly alluded to:

i. The mouth.—This may be passed by at once as the bullet usually so damages the base of the skull as to cause rapid death. It is just worth while to mention a possible cause of fallacy here, and that is, that a small revolver bullet, leaving an almost imperceptible track in the soft parts which have closed over it, may lodge in the upper cervical vertebræ, becoming, as it were, encapsuled, and lead to no future harm.

ii. The forehead.—From the presence of sinuses more or less developed, and of two tables, the progress of the bullet may be quickly arrested. The well-known fact that patients frequently recover after very severe injury to, and loss of substance of, the frontal lobes should also be remembered.

iii. The side of the head.—The thinness of parts of the skull here, especially the squamous bone, the subjacent motor area, the possibility of middle meningeal hæmorrhage, either at the time, or when the wound is explored, may be all points of importance.

The following questions will suggest themselves when a surgeon is called to a case of bullet wound of the skull:—

1. Has the bullet penetrated the skull at all? Thus it may have lodged, rebounded, or fallen out, or

2. It may have passed between the bone and dura mater, without penetrating the latter, and reached a spot quite out of sight. In such cases Sir T. Longmore advises the use of a curved probe, and extraction of the bullet "with suitable instruments," if it can be felt. Probably in most hands a second application of the trephine, if needful, at some distance from the wound, so as to extract the bullet here, would be preferable to attempts at removing it from the original wound.

3. Has the ball split into two or more pieces? Balls elongated as well as round are liable to split when impinging on sharp angles of bone. Thus, when the ball splits upon the outer table, part may pass beneath the scalp, while the rest may drive on

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* Mr. Barwell (*Clin. Soc. Trans.*, vol. xviii. p. 232) makes the following observation, which is of importance if it is found to be constant—viz., that, though the weapon may be held very close, there will be neither scorching nor powder-tattooing, if the bullet be driven by one of the modern fulminates, contained in the same cap with the projectile.

before it some of the internal table, causing pressure on the dura mater, or even reach the brain.

4. Has the bullet penetrated the brain? If so, where does it lie? Ought any further exploration to be performed, and, if so, ought this to be done through the original wound only or at some counterpoint as well?

Before attempting to answer these last questions, it may be well to deal with that which will be sure to arise first—viz., should the wound be explored or treated expectantly?

The following appears to me to decide in favour of exploring in all cases in which it is clear that the injury is not going to be quickly fatal:—

a. The fact that only by exploring will the surgeon be able to answer the question certain to be put to him by the friends whether the brain is injured or no.

b. Whether the bullet has split, whether the internal table is shattered, and, if so, how far it resembles a punctured * fracture, are also points which can alone be cleared up by trephining.

c. Good drainage, disinfection of the wound, are almost hopeless unless this is opened up and explored by trephining if needful.

The following case is not only a good instance of the kind of gunshot injury to the head which may be met with in civil practice, but it shows how slight may be the injury which actually originates the fatal mischief. It was brought before the Clinical Society by my colleague Mr. Lucas.†

The patient, aged twenty-one, had shot himself with a small revolver. "Almost in the centre of his forehead were two small circular holes, with slightly inverted edges. The surrounding skin was raised into a rounded eminence. There was some bleeding from the nose as well as from the wounds. On turning back flaps, a blackened cavity was opened beneath the skin, formed by the expansion of the powder after it had penetrated the integument. At the bottom of this cavity, a somewhat cruciform aperture was seen in the bone, and lying upon the internal table were two flattened bullets. The internal table was driven back so as to give the appearance of a sinus, in which the bullets were lying loose; and at the time we were under the impression that the man had very large frontal sinuses, which had been opened by the bullets. After removing numerous fragments belonging to the external table and diploë, the splintered internal table forming the posterior wall of the cavity was also removed. This came away in large, sharp-edged, angular fragments, two of which were grooved by the longitudinal sinus. When the internal table had been removed, the dura mater was seen at the bottom of the wound, and pulsating. The membrane was entire except at one spot, where there was a small aperture just such as might be made by stabbing the point of a penknife into a sheet of paper. But for that small puncture, it is not improbable that he would have recovered." Septic meningitis came on in about forty-eight hours, followed by death early on the sixth day.

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* Excellent instances of how closely some gunshot fractures may resemble the classical "punctured" fractures, not only in the greater damage to the internal table co-existing with but slight mischief externally, but also in the onset of grave symptoms inevitably fatal unless trephining has been performed early, are shown in figs. 79 to 88, *Med. and Surg. Hist. of the War of the Rebellion*, pt. i. pp. 168, 169.

† Vol. xii. p. 5.

Exploration, with or without trephining, in these cases should be conducted on the lines already laid down (p. 163). The chief differences are only in degree—viz., the greater care with which all fragments should be removed. Occasionally, portions of the bullet are found embedded with very great firmness in the diploë; these are best removed by careful use of gouge or chisel. If the dura mater is found to be injured, every attempt should be made to disinfect this from the first, and so obviate the otherwise inevitably fatal arachnitis. With blunt-pointed scissors, the aperture, if small, should be opened up, and a little iodoform, or equal parts of this and finely powdered boracic acid, dusted within the cavity of the arachnoid; or with a camel's-hair brush the parts may be carefully wiped over with a solution of mercury perchloride (1 in 500 or 800), and the above powder dusted on. An adequate-sized drainage-tube should be carried quite up into the skull opening, and retained in position here by strips of gauze carefully packed around. No sutures should be used, as a rule, in these wounds, where swelling of the scalp (it being impossible to render the parts rigidly aseptic) is sure to follow, and is very likely to interfere with the escape of discharges, and where primary union cannot be expected.

If, after exploring, the surgeon is certain that the bullet has penetrated the brain, another question arises as to the wisdom of further exploration and attempts at removal. As a rule, if the bullet is not found within 1 or 2 inches of the skull injury, nothing more should be done now, especially if the patient's condition is not good, or the anæsthetic's influence not well maintained. It is needless to say that in exploring the track in the brain the utmost gentleness is essential. As with fine metal probes, owing to the peculiar consistence of the brain, it is very easy to lose the track, and thus, at the same time, inflict fresh mischief, it will be wiser to make the gentlest possible use of a bougie (those with a double-silk web are the most suitable) after placing it for a few minutes in a solution of carbolic acid or mercury perchloride. If the bullet is found within 1 or 2 inches of the skull wound, it should be removed with a fine-pointed pair of dressing-forceps. It will be wise, if the track in the brain is much lacerated, to treat it like an abscess, and introduce a soft drainage-tube, to be gradually shortened.

The following points may be adduced for and against the attempt to remove bullets which have lodged in the brain :—

The surgeon who decides to abide by the expectant treatment in these cases both immediately after the injury and later on, can justify his course by a sufficient number of cases.* But it must always be remembered that many of these recoveries have been incomplete (*vide infra*), and that in many the patients have had very narrow escapes, and that in others the case has been reported much too soon to be of real value.†

On the other hand, no one, in my opinion, would blame the surgeon who, preferring exploratory to expectant treatment, endeavours to remove the bullet from the brain.

For while the cases of recovery after expectant treatment are few, it is probable that out of these, few as they are, a considerable proportion, if watched, would be found to be incomplete recoveries. Thus Dr. Otis ‡ writes of balls lodged within the cranial cavity: "Many instances were reported of patients who had survived the lodgment of missiles within the skull, but few or none resembling the cases reported by Larrey, of balls encysted in the brain and giving no inconvenience for years. It is, indeed, reported that some patients went to duty with balls lodged in the cerebrum; but the diagnostic details accompanying the history of these cases are not sufficiently precise to invite the fullest confidence. In most of the cases in which the evidence that the ball remained within the skull was conclusive, either fistulous sinuses existed, or there was much cerebral disorder,* or the position of the missile was discovered after the patient's death at a period remote from the injury."

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* *E.g.*, Dr. Brunton, *Lancet*, February 12, 1881; Mr. T. Smith, *Lancet*, May 3, 1879; and Otis, *loc. supra cit.*

† In the *Lancet*, August 14, 1886, is the abstract of a case reported to the Society of Surgery, at Paris, by M. Prengueber. The patient had fired a revolver at the middle of his temporal fossa, the bullet lodging in his brain. For the three days following the accident the surgeon abstained from interference, as the only symptoms were general prostration with lowering of the temperature. Epileptiform attacks having occurred on the fourth and fifth day, the wound was exposed and several bony spicula removed, which had penetrated the brain. A stilet having failed to detect the bullet, though passed along its course to a depth of five centimetres, nothing else was done. The epileptiform seizures did not recur, and the patient left the hospital at the end of a month, without any cerebral complication.

‡ *Med. and Surg. Hist. of the War of the Rebellion*, pt. i. p. 193.

The evil results of allowing a foreign body to remain in the brain are usually manifested sooner or later, even as long as thirteen years after the injury. Inflammation, slow or rapid, sometimes involving large portions of the brain-tissue, or yellow softening is apt to be set up around the foreign substance, either spontaneously, so to say, or from the most trivial exciting causes. The usual termination is cerebral abscess, this condition having been found in fifty-three cases in which a post-mortem examination was obtained. Apoplexy is an occasional cause of death, as is pressure of the foreign body on the venous trunks, inducing ventricular effusion and consequent compression of the cranial nerves. The probable explanation of those cases in which no symptoms have been present for long periods, but in which death has rapidly followed upon the sudden development of brain symptoms, is that quoted by Wharton from Flourens. This observer found that bullets introduced into different portions of the upper parts of the hemispheres and the cerebellum gradually penetrated the brain substance, ultimately reaching the basis cranii, the bullet tracks healing after them (Nancrede, from Wharton).

As to the fatality of wounds of the different portions of the brain, 58 deaths took place out of 132 cases where the foreign body entered through the frontal bone; 58 wounds of the parietal showed 27 deaths and 31 recoveries. The occipital bone was penetrated 23 times, with 16 deaths and 7 recoveries; the temporal bones 31 times, with 12 deaths and 19 recoveries (Nancrede, from Wharton).

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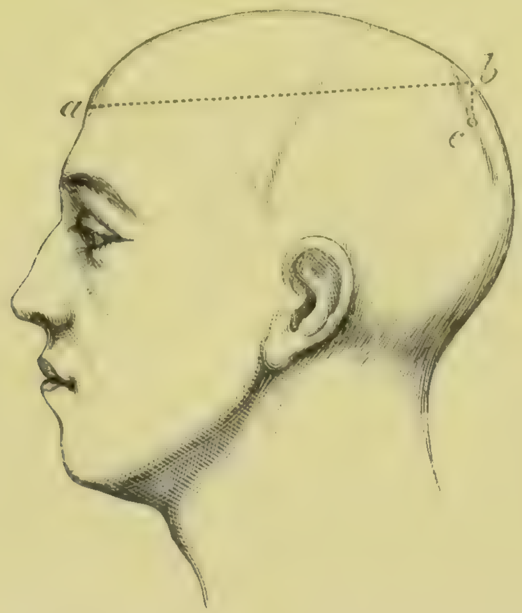
* Dr. Nancrede (*Intern. Encycl. of Surg.*, vol. v. p. 72) gives the following important abstract of a most careful paper by Dr. Wharton (*Phila. Med. Times*, 1879) in which 316 cases of foreign bodies lodged in the brain are analysed. Of these, 160 recovered, while 156 proved fatal. The influence upon recovery of the removal or retention of the foreign body was most marked. The foreign body was removed in 106 cases, 72 recovering, while only 34 died. In the remaining 210 no attempt at removal was made, and only 88 recovered, 122 dying. A further analysis shows that, amongst those cases classed as recoveries, death ultimately took place in 10 at periods varying from three to ten years, and that many of the patients suffered from such after-effects as vertigo, incapacity for physical exertion, loss of sight or hearing, epilepsy, and deteriorated mental powers.

The following is an interesting instance of successful operation for the removal of a bullet penetrating the brain.

FIG. 52.



a, *b*, Track of bullet and site of the trephine-openings. *c*, Spot where the bullet was found. (Fluhrer.)

The patient,* aged nineteen, shot himself with a pistol held very near to the centre of his forehead. About twelve hours afterwards, when seen by the surgeon, he was semi-conscious, aphasic, with complete loss of motion, without loss of sensation on the right side below the head. Left side hyperæsthetic. Pupils equally dilated. P. 100, T. 101.4°. Ether was given, and under the protection of copious irrigations of corrosive sublimate solution (1 in 1000), the wound of entrance, nearly in the centre of the forehead, was enlarged, including also the wound in the skull. This procedure was complicated by most profuse hæmorrhage from a branch of the anterior cerebral artery, which was finally controlled by small compression-forceps left *in situ*. To this arterial bleeding was added a considerable venous flow from the superior longitudinal sinus, which, like the artery, had been cut across by the bullet. The track of the ball through the brain was then examined by a straight Nélaton's probe,† and the point on the scalp noted at which the probe would emerge if projected through the head. At this point the cranium was exposed and trephined. The trephine-hole was enlarged towards the assumed opening of emergence of the bullet, and the dura mater slit in the same direction. Some effused blood and disintegrated brain matter appearing, more of the skull was cut away, and the slit in the dura mater prolonged, until a gush of brain matter, and a rent in the pia mater, demonstrated the point of impact of the bullet. The probe was introduced through the opening in the pia, and passed downwards towards a point where a feeling of resistance had previously been felt with the tip of a finger introduced through the second opening. At the distance of an inch the bullet was detected, and then extracted with slender-bladed forceps. It weighed 42 grains. One end of a small rubber drainage-tube was secured to one end of the probe; this was again passed through the brain from before backwards. The tube, as it was drawn through the wound, became filled with brain-detritus and blood. The after-history was one of gradual but progressive amendment. On the sixth day the drainage-tube was withdrawn, and replaced by a drain made of four strands of catgut and ten of horsehair, this being passed by tying it on to the anterior end of the drainage-tube. As the tube was withdrawn the drain occupied its place. It was removed, strand by strand, on different days. On the eighth day the compression-forceps was found to be loose. A hernia cerebri developed at both cranial openings. The herniæ being subjected to a slight continuous pressure, gradually disappeared. Eleven weeks after the operation, both wounds had healed. The operation was completed in about four hours, the greater part of the time having been spent in stopping the cerebral hæmorrhage. After leaving the hospital the patient returned to work, a slight impairment of memory being the only apparent consequence of his wound. A severe blow accidentally made upon the anterior scar some months after returning to work, determined a violent convulsive attack, which recurred at the end of three weeks. Bromides were freely given, and no further recurrence had taken place when the report was made six months later. The case will

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* This case was under the care of Dr. Fluhrer (*New York Med. Journ.*, March 28, 1885).

† Dr. Fluhrer considers that a probe for these cases should supply the following conditions. The end should be large, so as not to wound the brain and make a false passage, and also, when beneath the surface, be easily discoverable by palpation or dissection. It must be sufficiently rigid to retain a given shape,

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and sufficiently bulky to supply a large surface to the fingers. Finally, it should be as light as possible, that delicacy of touch be not lessened, and that no vibrations be lost instead of being communicated to the fingers. It should be made of tempered aluminium. If it is necessary to curve it near the exploring end (which increases the errors in interpreting the position of the extremity), the other end of the shaft should be bent, in the same plane, in the opposite direction.

amply repay careful perusal. It is a splendid instance of what surgical skill and sagacity can effect.

In the event of the bullet being embedded in the centre of the hemispheres, Dr. Fluhrer suggests the following ingenious steps for its extraction. He has tested them successfully on the dead body. The patient's head having been placed so that the path of the ball is perpendicular to the horizon, the probe is passed down to the ball. Contact being made with the bullet, the probe is pushed on till it is arrested by the opposite wall of the skull. The end of the probe is then exposed by trephining, and made to emerge. Two strands of disinfected silk are then tied to the end of the probe protruding from the opening of entrance. By drawing the probe through the head, the threads are left reaching through the wound. The probe is then re-introduced through the opening of entrance, and the exact depth of the bullet from that opening determined, but no attempt should be made to push it on, lest its relation to the existing wound through the brain be disturbed. The probe is then withdrawn. The distance of the ball from the opening of entrance is thus determined. A long probe or wire is so bent that its ends reach the two openings in the brain as a pair of calipers, and from the total length of the brain wound, as shown by measurement between the ends of the calipers, is subtracted the already determined measurement of the depth of the ball from the opening of entrance. In the effort to extract the ball there must be no groping outside the existing path in the brain. While this would inflict the most serious injury, the finding of the bullet would be rendered mere chance work. The path through the brain, leading directly to the ball, should be preserved by a suitable guide. This guide should not be of metal, as then it could not be distinguished from the ball. A carefully straightened gum-elastic catheter, No. 3, on its stylet is the best guide. So small a catheter, while it is sufficiently large and rigid, leaves some room for exploration. One of the threads at the opening of entrance is, with a needle, carried through the centre of the end of the catheter and out of its eye, and tied fast. By means of the conducting thread, the catheter is, with its stylet, carefully lodged in the wound through the brain, its ends projecting from the skull. This having been done, the reserve thread through the wound should be withdrawn. The head should now be turned, so that the guide lies nearly in a horizontal plane, easy for manipulation. The instrument for extracting the bullet is a pair of long, slender-bladed, double-toothed, self-closing cervix-forceps. The action of this should have been tested with a view to avoid displacement of the bullet in an attempt to seize it. The forceps is prevented from straying from the single and straight path leading to the ball by tying it to the guide. The end of one of the blades is notched behind the teeth. A delicate, but strong, silk thread is tied to the blade at this place, and is thus prevented from slipping. The thread is then tied in a loop a little larger than the eye of the guide, the ends being cut short to the knot. The loop is passed over the guide, and the closed forceps introduced, alongside of, and parallel to, the guide, into the wound in the brain. If the loop fails to slip upon the guide, the guide should be allowed to move with, and as a part of, the forceps. If the end of the guide is likely to be carried within the skull, it can be easily pushed back while the forceps is held immovable. With the lightest and most sensitive touch, search is made on one side of the guide to the known depth of the ball. This failing, the forceps is withdrawn, and the bullet sought for on the other side of the guide, and then above and below. When the bullet is felt, care should be taken to make an effectual seizure. The bullet and guide should be withdrawn together. A fragment of bone, deeply lodged in the brain, could be removed in the same way. If all attempts fail, a path for drainage leading to the ball has been established. Dr. Fluhrer thinks it may be assumed that the ball would tend towards this path, along the line of least resistance, and that a second search, four or five days later, might succeed.

B. Other foreign bodies besides bullets which may penetrate the brain are knife-points. These, with their tendency to form cerebral abscess, have already been alluded to, p. 161.

C. Another class of body which may be met with by the surgeon in civil practice is shown in the following case of Mr. Couper's.* A house-painter fell twelve feet from a ladder, impaling the right side of his skull on the spike of an iron palisade. When brought into the hospital there was a clean cut wound three-quarters of an inch long, immediately under the right ear, partly overlapped by its lobule. In this the end of a large rough piece of metal, corresponding to a freshly broken spike, could be felt, and its direction could be inferred to be upwards, inwards, and a little forwards from the outer wound, which was situated half an inch under the external meatus between the mastoid process and the ramus of the jaw. There was some bleeding from the right ear, but no facial or other paralysis. The patient being under chloroform, Mr. Couper succeeded, after much forcible wrenching, in extracting the iron, the head being as far as possible steadied by three students and the operator's hand. During these efforts 3 or 4 ounces of blood oozed from the wound; this hæmorrhage ceased as soon as the iron was out, but a small quantity of semi-fluid brain substance flowed. Right facial paralysis came on two days after the injury, then delirium, restlessness, and on the seventh day left hemiplegia, followed by convulsive attacks, affecting the right limbs and right half of the face. Two days later, or nine days after the accident, the patient died.

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* *Lond. Hosp. Reports*, vol. ii. Hutchinson's *Clin. Surg.*, vol. i. p. 91, pl. xvii.

Post-mortem.—No pus between dura mater and bone; dura mater healthy, save for congestion. On opening it, the surface of the right hemisphere showed well-marked sub-arachnoid meningitis. The posterior part of the right middle cerebral lobe had been deeply wounded; the brain substance, at this spot softened, and streaked with pus, was healthy everywhere else. The spike had entered just under the apex of the mastoid process, traversed the internal ear, and driven several irregular masses of petrous bone through the dura mater.

Probably, in a similar case, the careful use of chisel or gouge would loosen the foreign body, while the opening up of the wound would facilitate drainage, and cleansing the parts damaged, including the brain itself.

TREPHINING FRONTAL SINUSES.

Prof. Ogston* has advised the use of the trephine in cases of retention of secretion and chronic inflammation of the lining membrane of these sinuses.

Indications.—Uneasiness, pain over forehead and tenderness on firm pressure, with occasional escape from the nose of thick pus, the appearance of which is not to be otherwise accounted for.

The above are due to retention analogous to that causing empyema of the antrum. As no probe can be passed from below, when all other treatment fails, the sinuses should be opened above, and their communication with the nose dilated.

Operation.—A single vertical incision is made down to the bone, commencing at the root of the nose, and extending upwards for an inch and a half over the nasal eminence of the frontal bone. The periosteum having been divided and carefully cleared back, a trephine, the size of a sixpence, is applied in the middle line.

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* *Med. Chron.*, vol. i. No. 3, p. 1.

When the trephine has been found to enter a cavity which the point of a quill or a probe shows to lie rather at the lower part of the crown, the disc is removed. If the sinuses are large, this is readily effected, but if they are small, the disc must be removed piecemeal, with a mallet and chisel, until the sinuses are laid bare. The bleeding is slight.

The object which now meets the eye is the livid mucous membrane lining the sinuses. On opening it, it is found thickened, and to contain mucus or muco-pus. This being sponged away, and the orifice in the nose found* with a probe or a fine gum-elastic catheter, a drainage-tube, about the size of a crow-quill, should be slid down into the nose, and its upper end left in the sinus, the skin being united over it, to secure union by first intention.†

If, however, owing to great thickening of the mucous membrane, foul caseous pus, &c., it is necessary to use the sharp spoon, and to disinfect the recesses of the sinuses by syringing out, insufflation with aseptic powder, or brushing over with zinc chloride or silver nitrate solutions, it will be wiser to run the risk of more tedious closure of the opening, and to bring the upper end of the drainage-tube out on to the forehead, only partly closing the wound around.

In 1886 I performed a similar operation in a case of syphilitic necrosis affecting the upper turbinated bones, ethmoid, and nasal spine of the frontal bone. The frontal sinuses being freely opened up, the necrosed bone was removed from above and below, and a large drainage-tube brought out by the forehead and nose. A condition of fœtor and nuisance soon became one of cleanliness and comfort, and an excellent recovery ultimately took place with very little deformity.

It is probable that analogous operations would be found useful in very obstinate cases of ozæna, in which there is evidence of the mischief having extended to the frontal sinuses, and in which, therefore, other treatment, including Rouge's operation (p. 289), will be insufficient.

Every attention should be paid to keeping the wounds as aseptic as possible, and to preventing erysipelas. A dressing of boracic acid lint, wrung out of a saturated solution of boracic acid, iced if needful, frequently renewed, or kept wetted, will be found efficient.

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* If the opening be too small, Prof. Ogston advises that it should be enlarged by thrusting down a trocar or stout director.

† In one of Prof. Ogston's cases a small fistula persisted for some time.

CHAPTER III.

CEREBRAL LOCALIZATION IN REFERENCE TO OPERATIONS.

OPERATIONS ON THE BRAIN.

CEREBRAL LOCALIZATION IN REFERENCE TO OPERATIONS (Figs. 53, 54, 55).

SUFFICIENT cases are now recorded in which, by attention being paid to the cerebral motor centres, a lesion has been diagnosed and localized, and an operation has saved or relieved the patient. It only requires more close watching of head cases, more careful weighing of signs and symptoms, for such instances to be largely increased.

Motor Area.—The motor area, or that part of the cortex in which lesions cause paralysis on the opposite side of the body, lies beneath the anterior half of the parietal bone. It may be said to be in form a parallelogram, about an inch wide, with its centre traversed obliquely by the fissure of Rolando.

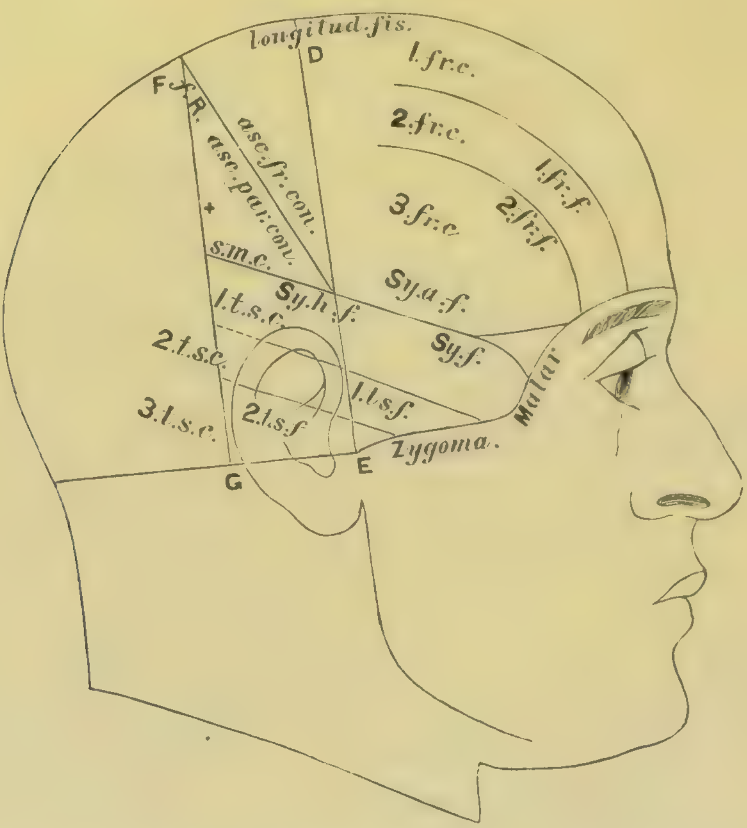
Speaking succinctly, but perhaps with sufficient accuracy for practical purposes, the centre of speech lies (on the left side) at the lower and anterior angle, or a little below and in front of the area. Paralysis or convulsions limited to one lower extremity need the trephine at the upper end of the opposite motor area, paralysis of the arm at the middle third, paralysis of the face at the lower third. Three applications of a trephine with chipping away of bone will expose it for thorough examination; if the paralysis is distinct and limited, one or two applications will probably suffice to find the lesion. Where lesions are combined (foot-note, p. 221), points intermediate between the respective centres must be exposed.

The following aids in finding the above most important fissure will be found useful:—

i. The upper end of the fissure is found about ½ inch behind a point midway between the root of the nose and the external occipital protuberance; the lower end is about 1 inch behind the bifurcation of the Sylvian fissure. This bifurcation corresponds to a point 2 inches behind and ¼ inch above the level of the external angular process of the frontal bone.

Mr. Godlee, in a most interesting case (p. 224) of trephining for cerebral tumour, used the following simple method of exposing the fissure of Rolando in its middle third:—

FIG. 53.



+ Most prominent part of parietal eminence.* *f.R.*, Fissure of Rolando. *Sy.f.*, Sylvian fissure. *Sy.h.f.*, Horizontal line of Sylvian fissure. The ascending limb would start 2 inches behind and a little above the external angular process, running straight up for an inch between the letters *a* and *f* at *Sy.a.f.* 1 and 2 *fr.f.*, First and second frontal fissures. 1, 2, 3, *fr.c.*, First, second, and third frontal convolutions. 1 and 2 *t.s.f.*, First and second temporo-sphenoidal fissures. 1, 2, 3, *t.s.c.*, First, second, and third temporo-sphenoidal convolutions. (After Reid.)

(1) A line was drawn between the frontal and occipital protuberances.

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* I think that this point is, in Fig. 53, placed too far back. Messrs. Anderson and Makins, in a paper on "Cranio-cerebral Topography" (*Journ. Anat. and Phys.*, vol. xxiii. p. 455), state that the parietal eminence is usually placed about midway in a line corresponding to ED, Fig. 53. While the parietal eminence is liable to vary, I should have thought that it was very rarely placed so far forwards as the above writers state. Prof. Turner (*loc. infra cit.*) considers that this eminence corresponds to the supra-marginal convolution.

(2) At a right angle to this a line was drawn vertically downwards through the front of the external auditory meatus.

(3) Parallel to the last a line was drawn vertically upwards at the level of the posterior border of the mastoid process, reaching the longitudinal line (1) about 2 inches behind the second.

(4) From the junction of the lines 1 and 3, one was drawn diagonally downwards, reaching the second about 2 inches above the external auditory meatus. This was believed to represent the direction of the fissure of Rolando.

ii. Dr. Reid[*] gives the following directions for finding the fissure of Rolando (Fig. 53):—A line is first drawn from the root of the nose to the external occipital protuberance, the horizontal limb of the fissure of Sylvius[†] (*Sy.h.f.*) is next marked out, then from a base-line (EG) running through the lowest part of the infra-orbital margin and the centre of the external auditory meatus, draw two perpendicular lines to the top of the cranium, one from the depression in front of the external auditory meatus (ED), and another from the posterior border of the mastoid process (GF). There is then described on the surface of the head a four-sided figure bounded above and below by the lines for the longitudinal fissure and horizontal limb of the fissure of Sylvius respectively, and in front and behind by the two perpendicular lines. If a diagonal line (*f.*R) is now drawn from the posterior superior to the anterior inferior angle of this space, the line will lie over the fissure of Rolando.

The following are M. Lucas-Championnière's (*loc. infra cit.*) directions for finding the fissure of Rolando. The upper end is situated 2.2 inches behind the bregma (*vide infra*). The position of the lower end is thus determined. From the very end of the external orbital process, where this rises up to join the temporal crest, draw a horizontal line of 2¼ inches, and from the extreme end of this draw a vertical line of a little over 1 inch. Between these two points, passing rather obliquely forwards, lies this fissure.

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[*] *Lancet*, September 27, 1884. From this paper Fig. 53, slightly altered, has been taken.

[†] The fissure of Sylvius (Figs. 53, 54, 55) is found by drawing a line from a point 1¼ inch behind the external angular process of the frontal bone to a point ¾ inch below the most prominent part of the parietal eminence. Measuring from before backwards, the first ¾ inch of this line will represent the main fissure, and the rest its horizontal limb. The ascending limb will start 2 inches behind and slightly above the external angular process, and runs vertically upwards for about an inch.

I have given several methods * for finding the fissure of Rolando, as some authorities—*e.g.*, Prof. Cunningham—have found Dr. Reid's unreliable. With regard to the directions already given and those to follow, it must be remembered that the eminences and sutures of the skull, and the relations of the sulci and convolutions beneath to the cranial surface, are liable to variations.† I believe that the points here given will be found easily defined, and occupying a central position with regard to the brain beneath and its possible variations. The surgeon must be prepared to use his trephine freely.

Position of the Chief Sutures (Figs. 54 and 55).—After considering that most important part of the brain, the motor area, which lies under the parietal bone, it will be well to recall the landmarks of the chief sutures which are met with in that region. The coronal suture, the anterior limit of the parietal bone, may thus be traced. The point where it leaves the sagittal suture, the bregma, may be found by drawing a line from a point just in front of the external auditory meatus straight upwards on to the vertex; from this point the coronal suture runs downwards and forwards, speaking roughly, to the middle of the zygomatic arch, or, more exactly, to join the temporal part of the great wing of the sphenoid, which it meets an inch and a half above the zygoma, and not quite an inch behind the external angular process of the frontal bone.‡

Under this suture lie the posterior extremity of the three frontal convolutions (Fig. 54), for the frontal lobe lies not only

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* Mr. Hare (*Journ. of Anat. and Phys.*, vol. viii.) suggests the following table as one that gives the upper extremity of the Rolandic fissure in heads of ordinary size :—

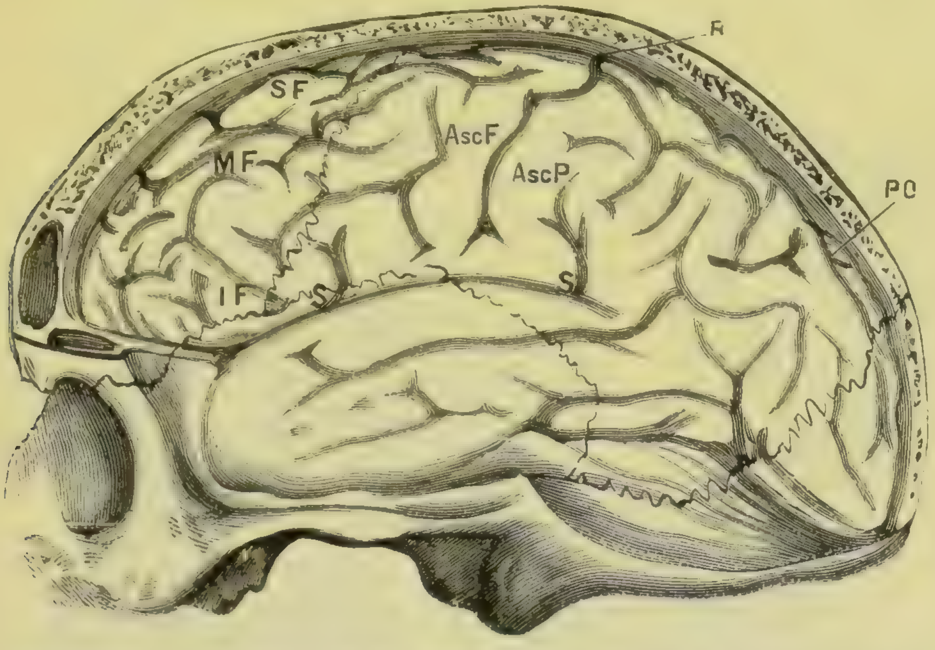
Where the Distance from Glabella to External Occipital Protuberance is—	the Fissure of Rolando will lie behind the Glabella—	Where the Distance from Glabella to External Occipital Protuberance is—	the Fissure of Rolando will lie behind the Glabella—
11 inches ...	$6\frac{1}{10}$ inches	$13\frac{1}{4}$ inches ...	$7\frac{3}{10}$ inches
$11\frac{1}{4}$,, ...	$6\frac{3}{10}$,,	$13\frac{1}{2}$,, ...	$7\frac{1}{2}$,,
$11\frac{1}{2}$,, ...	$6\frac{2}{5}$,,	$13\frac{3}{4}$,, ...	$7\frac{3}{5}$,,
$11\frac{3}{4}$,, ...	$6\frac{1}{2}$,,	14 ,, ...	$7\frac{7}{10}$,,
12 ,, ...	$6\frac{3}{5}$,,	$14\frac{1}{4}$,, ...	$7\frac{9}{10}$,,
$12\frac{1}{4}$,, ...	$6\frac{4}{5}$,,	$14\frac{1}{2}$,, ...	8 ,,
$12\frac{1}{2}$,, ...	7 ,,	$14\frac{3}{4}$,, ...	$8\frac{1}{5}$,,
$12\frac{3}{4}$,, ...	$7\frac{1}{10}$,,	15 ,, ..	$8\frac{3}{10}$,,
13 ,, ...	$7\frac{1}{5}$,,		

† See papers by Prof. Turner, *Journ. of Anat. and Phys.*, vol. xviii.; Mr. Hare, vol. viii.; and Messrs. Anderson and Makins, *loc. supra cit.*

‡ I have pointed out—"Middle Meningeal Hæmorrhage," *Guy's Hospital Reports*, vol. xliii.; p. 152, pl. iv. fig. 3—how thin the bone is in the vicinity of the coronal suture.

under the frontal bone, but extends backwards under the anterior part of the parietal, the fissure of Rolando, which forms the posterior boundary of the frontal lobe, lying from 1½ to 2 inches behind the coronal suture.*

FIG. 54.



The above view of the brain *in situ* shows the relations of the surface convolutions to the regions of the skull. R, Fissure of Rolando, separating the parietal from the frontal lobe. PO, Parieto-occipital fissure between the parietal and occipital lobes. S, S, Fissure of Sylvius, separating the temporo-sphenoidal from the frontal and parietal lobes. SF, MF, IF, The superior, middle, and inferior frontal convolutions. Asc. F., Ascending frontal convolution. Asc. P., Ascending parietal convolution. The outlines of the coronal, squamoso-parietal, and lambdoidal sutures are also seen. (After Turner.)

The occipito-parietal or lambdoidal suture, the posterior limit of the parietal bone, will be marked out by a line which starts from a point 2¾ inches above the external occipital protuberance, and runs forwards and downwards to its termination, which will be found on a level with the zygoma, 1¼ inch behind the meatus.

As the occipital lobe is not limited to the upper portion of the occipital bone, but extends forwards under cover of the posterior part of the parietal, the parieto-occipital fissure lies about ¾ inch in front of the apex of the lambdoid suture (Fig. 54). But this varies a good deal according to the ossification of the squamous part of the occipital.

The squamous or squamoso-parietal suture is not so easy to mark out, owing to the irregularity of its curve and variations. Its highest point is usually 1¾ inch above the zygoma (Fig. 55).

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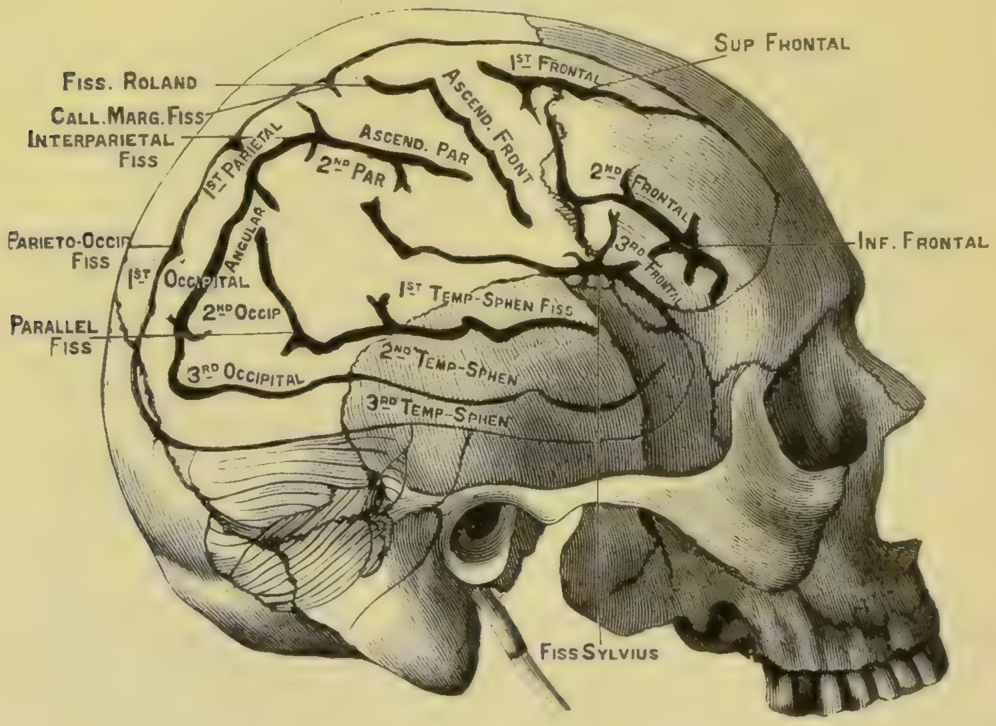
* Prof. Hare (*loc. supra cit.*) gives the average distance in eleven skulls as 1⅞ inch. M. Lucas-Championnière (*loc. infra cit.*) states it at 2⅕ inches.

The Sylvian fissure, which separates the temporo-sphenoidal from the parietal lobe, passes from below obliquely upwards and backwards across the line of this suture near its middle (Fig. 55), the temporo-sphenoidal lobe not only lying under the squamous and great wing of the sphenoid, but passing upwards under cover of the lower part of the parietal. In Prof. Turner's words, this fissure commences immediately behind the posterior border of the lesser wing, and in its course backwards and upwards is covered by the great wing of the sphenoid where it articulates with the anterior inferior angle of the parietal. It then passes obliquely under cover of the anterior superior part of the squamous bone, and appears in the lower part of the antero-parietal region.

FIG. 55.*



The chief convolutions and fissures on the outer surface of the brain, together with the outlines of the sutures and bones beneath which they lie. Diagrammatic. (After Roberts, of Philadelphia.)

The following practical points are given by Prof. Nancrede:†—

(1) Monoplegia or spasms limited to one member, or a portion of one member, indicate limited lesions. If the lower limb be affected, the upper portion of the ascending parietal (Fig. 55), with perhaps also the corresponding part of the ascending frontal,

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[*] The above woodcut is taken from Dr. Robert's paper on the "Operative Surgery of the Human Brain," *Annals of Surgery*, August 1885, p. 119.

[†] *Internat. Encycl. Surg.*, vol. v. p. 90.

is involved. A trephine-crown must then be applied about the upper part of the Rolandic line.

(2) With paralysis of the arm and leg, the lesion probably involves the upper two thirds of the ascending convolutions, with the paracentral lobule. The trephine should then be placed at the upper part of the line, a little lower than in the former case. It may perhaps be necessary to enlarge the opening by cutting out a circle lower down.

(3) Paralysis of the upper extremity alone probably indicates injury to the middle third of the ascending frontal convolution, and the trephine should be applied a little in front of the middle third of the fissure of Rolando.

(4) Paralysis of the lower part of the face points to a lesion of the inferior third of the ascending convolutions, or of the foot of the second frontal.

(5) In simple aphasia the trephine-crown should be placed lower down still, in front of and below the lower extremity of the fissure of Rolando.

(6) In most cases many centres are affected,* and consequently the surface to be exposed is much larger. Thus:—

With paralysis of both lower extremities, the summit of the line and the contiguous superior portion of the cranium must be removed. With paralysis of one upper and one lower extremity (hemiplegia), the operation must be performed at the middle and upper portion of the line; in paralysis of the arm with facial palsy, at the inferior third of the line, and a little in front; in palsy of the upper extremity with aphasia, the opening should be made below and in front of the line; with facial paralysis and aphasia, the bone should be removed well in front of the left line, and below its inferior extremities.

The above statements from Dr. Nancrede, following M. Lucas-Championnière,† are liable to revision with advancing knowledge.

The following location of the chief cerebral centres is thus given by M. Lucas-Championnière. *Lower extremity.*—Summit of the ascending parietal convolution. *Upper and lower extremity.*—Summit of the ascending parietal and frontal convolutions. *Upper extremity.*—Middle portion of the ascending frontal convolution. *Upper extremity and aphasia.*—Lower third of the ascending frontal, and foot of the third frontal convolution. *Facial Paralysis.*—Lower third of the ascending frontal, and foot of the second frontal. *Aphasia.*—Foot of the third left frontal.

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* The following combinations are those usually met with (Nancrede, *loc. supra cit.*, p. 89):—Paralysis of face and aphasia; aphasia and paralysis of the arm; paralysis of arm and face; paralysis of the upper and lower extremities.

† *La Trépanation guidée par les Localisations cérébrales*, Paris: 1878. These statements will be found to differ somewhat from those taught by Dr. Ferrier, p. 227.

Contra-indications to Trephining in Lesions of the above Cerebral Centre.—Any evidence of base-lesions, *e.g.*, paralysis of one or more cranial nerves, or Cheyne-Stokes' respiration. Also hemiplegia, accompanied by marked anæsthesia, contra-indicates operation, as the latter symptom points to lesions which implicate other portions of the encephalon than the motor area, and which are too deeply seated to be accessible to operative interference.

PRACTICAL VALUE OF CEREBRAL LOCALIZATION.

I propose to give instances of this under the following headings:—(A) In head injuries; (B) In brain growths.

(A) **Cerebral Localization in the Diagnosis and Treatment of Injuries to the Head.**—A typical case, in which localization may help the surgeon in trephining, would be one in which the injury is limited to the cranium, and is followed immediately by paralysis. Secondary or tardy paralysis may be the result of later inflammatory processes.

M. Lucas-Championnière (*La Trépanation guidée par les Localisations cérébrales*, p. 107) gives this interesting case:—

A man was found in the street with slight paralysis of the right arm, but sensibility perfect. There was a slight superficial cut, ½ inch long, over the left parietal eminence. Five or six days later the patient became stupid and unable to swallow, and convulsions* increasing in violence, and involving all the body, save the right forearm and hand, set in. Suspecting a fracture of the inner table, M. Lucas-Championnière trephined at the site of the wound, and found a fine fissure just in front of this; there was slight depression of the fragments, which were wedged tightly together. After the operation the convulsions ceased, and a good recovery took place, with use of the right arm. The fracture was proved by measurements to be over the middle and lower part of the fissure of Rolando, considerably in front of the scalp wound.

The following case of cerebral lesion (Intra-cranial Subdural Effusion of blood) diagnosed from motor symptoms alone was given by Dr. Macewen in his most striking address at the Glasgow meeting of the British Medical Association (*Brit. Med. Journ.*, Aug. 11, 1888):—

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* Convulsions in themselves are only an indication for interference when they are localized and persist, and especially if they alternate with paralysis of the same muscles.

A boy had, consecutive to a fall six days before, convulsions, the twitchings beginning in the left side of the face, gradually involving the left arm and subsequently the left leg, consciousness being preserved. Paresis of these parts remained, though sensation was unimpaired. The parts were always affected in the same general order, and the convulsions, persisting, finally became general, with loss of consciousness. These motor phenomena indicated a lesion on the right side of the brain, pronounced at the middle and lower part of the ascending convolutions, as the face and arm centres were the first to show evidence of stimulation. The lesion was evidently of an irritative kind, such as might be caused by a bone-spiculum driven into the brain, or by pressure on its surface. It was clearly not destructive, *e.g.*, a severe cerebral contusion. It was resolved to expose the lower part of the fissure of Rolando. The head being shaved, a scarcely perceptible irregularity was detected near the coronal suture. Trephining was performed at a point slightly behind the auriculo-bregmatic line, and midway between the auditory meatus and the vertex. This happened to correspond to the posterior extremity of a fissure which ran across the coronal suture. There was no extra-meningeal hæmorrhage, but the dura was very dark. On opening this, 2 ounces of clotted blood escaped from the subdural cavity. There was no recurrence of the fits, and the patient survives in perfect health.

Case* of Traumatic Aphasia successfully treated by removing Blood-clot from the interior of the Cerebrum—

The patient had been struck on his head with a penknife six days before admission. At that time he had difficulty in speaking correctly, which had increased somewhat, and pain in the left side of the head, but no paralysis or loss of sensation. A small scar was found over the left squamous bone, 2 inches from the external angle of the orbit, and $\frac{3}{4}$ inch above the zygoma. Both forms of aphasia (motor, speaking; and sensory, word-blindness) were to a certain extent present. Five days later the scar was explored, and a wound of the squamous bone, in size and shape likely to have been produced by a small penknife, found, and cut out in a trephine-circle. The knife had penetrated the dura and brain, the large posterior branch of the middle meningeal just escaping. The dura being opened, a sinus-forceps was gently passed along the brain wound, and, on separating the blades, a blood-clot presented, and was gradually extruded by brain-pressure. Some more was removed by the forceps and by a stream of weak mercury-perchloride solution. A drainage-tube was inserted. On the evening of the same day the aphasia was much improved. Next morning the patient was again more aphasic, and it was found that the tube had become blocked. On freeing it, much fluid with broken-down clot escaped, and the power of speech improved. The patient recovered uninterruptedly, regaining completely his power of writing, reading, and speaking. Dr. Ball believed that the knife had penetrated the superior temporo-sphenoidal gyrus, traversed the Sylvian fissure, and probably injured Broca's convolution.

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* Dr. C. B. Ball, *Trans. Roy. Acad. of Med. Ireland*, vol. vi. p. 155.

(B) **Cerebral Localization in the Diagnosis and Removal of Cerebral Tumours.**—Amongst the cases which have been published there have been none to surpass in helpfulness, from the completeness of the details and the accuracy of its reasoning, one of the earliest of the cases submitted to modern surgery—viz., that trephined by Mr. Godlee* for Dr. Hughes Bennett, in 1884, an abstract of which is given below.

A man, aged twenty-five, had, four years before, suffered from slight concussion from a blow on the left † side of the head. A year later first set in twitchings in the left side of the mouth and tongue, paroxysmal and irregular in occurrence. Some months later fits began, with loss of consciousness and general convulsions. This condition lasted two and half years; and six months before admission, twitchings of left hand, followed shortly by weakness of the left fingers, hand, and forearm, were noticed. For three months these had prevented his using his tools. During this last period there had been twitchings of the left leg, which had also been getting weak. There was nothing abnormal in the skull or scalp. Vision was normal, but optic neuritis was present on both sides, most marked on the right. Hearing was less acute in the right. There was more complete paralysis of the left fingers, thumb, and hand, the elbow movements were very limited, those of the shoulder impaired. There was no rigidity or wasting of muscles. The toes of the left leg did not clear the ground in walking. There was persistent vomiting and retching, with attacks of lancinating headache, rendering life intolerable. Large doses of the iodides were fruitless.

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* *Med.-Chir. Trans.*, vol. lxviii. p. 244.

† Whether the glioma on the right side of the brain was due to a blow on the left side must be uncertain.

An operation being decided on, the motor area and the diagonal line representing the fissure of Rolando was mapped out by the proceedings already given at p. 216. Theoretically, in order to hit the middle of the fissure of Rolando, the centre of the trephine should have been placed about ½ inch behind the diagonal line, and about 1½ inch from the median longitudinal line. As, however, there was a tender spot on the scalp 2 inches anterior to this, the first opening was made (with a trephine 1 inch in diameter) between the two.* The dura mater was normal; after a crucial incision was made in it, the brain was thought to bulge abnormally, and to be rather more yellow than usual, otherwise it was healthy. A second crown was cut away, overlapping the first, external to and slightly in front of it, and the angles of bone rounded off with a chisel and hammer, the brain being protected with a copper spatula. These two openings were then joined by one posterior to them, and, the edges being chipped away, a triangular aperture was left measuring 2 by 1¾ inch. The dura mater was opened, and a surface of brain exposed nearly equal in size to that of the skull-opening. Occupying most of this space, and crossing it obliquely from above and behind, downwards and forwards, was a convolution. Into the centre of this convolution an incision about ¾ inch in length was made with a scalpel. From ⅛ to ¼ inch below the surface lay a transparent, lobulated, solid tumour, thinly encapsuled, but quite isolated from the surrounding brain substance. The incision into the cortex being prolonged, the sides of the growth were easily separated by a spatula of steel, readily bent into any shape. The superficial surface of the growth being thus isolated, this portion was removed with the finger; as part now broke away, the deeper parts were enucleated with a sharp spoon, the scraping being continued till apparently only healthy brain-matter remained. This caused rapid welling up of blood into the cavity, which would have held a pigeon's egg. Sponge-pressure failing, the hæmorrhage was finally arrested with the electro-cautery. The dura mater was drawn together with sutures, and a drainage-tube inserted beneath it. Elsewhere the skin was brought accurately together. Antiseptic precautions, including the spray, were used throughout. The anæsthetic, chloroform, was taken well.

The wound was not dressed till the third day, when the discharge had a distinctly putrefactive smell: the scalp near the wound was somewhat œdematous. The next day wet boracic-acid dressings were applied, there was hardly any trace of smell, but a hernia cerebri as large as half an orange was protruding through the lips of the wound. There were no twitchings of limbs or face, no headache. The patient was bright and cheerful, with good appetite. The hernia cerebri, however, increased, and on the eighth day, having reached the size of half a cricket-ball, was snipped away with scissors, the parts removed consisting chiefly of granular matter and clot, with, apparently, little true cerebral stricture. The cut surface was treated with a strong solution of zinc chloride and iodoform, and a cap of block-tin applied. The hernia cerebri again increased somewhat, but all seemed to be doing well, when, on the twenty-first day, a rigor appeared, headache followed and vomiting, then restlessness, sleeplessness, and gradual sinking about four weeks after the operation.

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* The centre of the opening was 1¼ inch from the middle line and ½ inch behind a line drawn vertically upwards from the meatus of the ear.

At the post-mortem examination extensive arachnitis was found. The parietal area appeared to have fallen in; in its centre, and occupying the position of the fissure of Rolando, was the wound in the brain. The destruction of the cerebral cortex involved nearly all the ascending parietal convolution, the upper part of the ascending frontal, and the anterior third of the supra-marginal gyrus. The extent of softening around was not great, but it was difficult to tell this accurately, as the brain had undergone the process of hardening. The original growth was a glioma, of the size of a walnut.

In commenting on the case, most interesting remarks are grouped under the following heads: (1) Diagnosis. (2) Surgical treatment. (3) Clinical phenomena after the operation. (4) Revelation of the autopsy physiologically and pathologically considered.

These will well repay most careful perusal; only the chief points can be given here.

(1) *Diagnosis.*—A brain growth on the right side was diagnosed in this case on the following grounds:—Slow progress, uncontrollable vomiting. Violent pains. Double optic neuritis. It was thought to occupy the cortex because certain motor tracts were implicated in definite order, because paralysis was present without loss of sensibility, and above all because of certain paroxysmal seizures of local convulsions occurring without loss of consciousness, eminently suggestive of irritation of the grey matter.

The special seat of the lesion was believed to be in the middle part of the right fissure of Rolando. Following Prof. Ferrier, the motor centres which govern the voluntary movements of the lips and tongue are situated in the lower portions of the ascending parietal and frontal convolutions. Higher up, in the same gyri, are the motor centres for the face-muscles. Occupying the middle and nearly all the ascending parietal convolution are the centres of the fingers and hands. In the middle of the ascending frontal convolution are the centres for movements of the arm and upper arm, including flexion, pronation and supination of the forearm. At the upper and back part of the ascending parietal convolution is the centre for the lower extremity, and at the upper and anterior portions of the ascending frontal convolution are the centres for complex movements of both the upper and lower limbs.

In this case there was complete paralysis of the fingers and hand, with inability to pronate and supinate the forearm, there was partial paresis of the movements of the elbow, and weakness of those of the shoulder-joint. There was also slight paresis of the leg and one side of the face. Accompanying all these there were paroxysmal convulsions in all these regions, occurring either singly or in definite order one after the other. These phenomena were to be accounted for by an extensive but not absolutely complete destruction of the motor centres of the fingers, hand, and forearm, with slight encroachment on and irritation of those of the face, upper arm, and leg. A very definite localization was thus permitted, and the tumour was pronounced to have occupied the whole thickness of the middle two-fourths of the ascending parietal convolution, and a portion of the adjoining upper half of the ascending frontal convolution.

The growth was proved to be limited by the fact that the centres of the leg above, of the face and tongue below, of sight behind, and of the movement of the eyeballs in front, were not seriously involved. It could not have exceeded 2 inches in diameter, and proved to be a glioma, of about the size of a walnut, lying obliquely in the fissure of Rolando. As to the probable nature of the tumour, the age of the patient, the absence of syphilis, and the slow progress, suggested glioma.

(2) *The Operation.*—In this the advantages of the chisel and hammer over Hey's saw were exemplified. Mr. Godlee considers that the use of a larger trephine might be advisable in similar cases. One convolution only being exposed during the operation, there was at the time some question as to whether it was the ascending frontal or parietal. This doubt arose from the circumstance that

in the attempt to approach the tender spot the theoretical position had been slightly departed from. After death, however, it was apparent that the convolution which had been incised was that in which from the first the disease had been diagnosed to exist—viz., the ascending parietal. There was no external appearance of disease about this part except that it seemed swollen, less glossy, and less vascular than natural. An incision into this showed the morbid growth to be immediately under the surface, and almost completely involving the entire thickness of the cortex. In clearing away the superficial parts of the growth a small spatula, neither sharp nor blunt, and so tempered that it would keep any shape given to it was found most serviceable, and much preferable to the use of the cautery, as this so chars the parts as to prevent a differentiation between healthy and diseased tissues. It may be questioned whether it was advisable to arrest the hæmorrhage from the interior of the wound by means of the galvano-cautery, as the bleeding was not severe and would no doubt have become arrested by natural means. The use of this instrument appears to have brought about the putrefaction which was the cause of the inflammation and consequent hernia cerebri. It may be doubted if the putrefaction was ever completely subdued; the fact of the meningitis occurring at last, and that of smell having again become apparent after the attempt at removal of the second protrusion, point probably to a continued septic infection. As to the hernia cerebri, it was remarkable in the first place that the discharge continued for so long to be so copious and so watery as to suggest the idea of its being cerebro-spinal fluid.* Secondly, there was a difficulty in shaving it off owing to the enormous size of its base and the danger of serious hæmorrhage.

(3) *Clinical Phenomena following the Operation.*—The patient lost his headache, vomitings, and violent twitchings in the limbs; even the double optic neuritis markedly diminished. The only change which followed the operation was completion of the paresis of the upper extremity, evidently due to the unavoidable destruction of the remaining arm-centres in the removal of the tumour. Coincident also with the formation of the hernia cerebri came fresh symptoms, in the shape of paresis of the left leg and partial anæsthesia of one-half of the body. These were probably

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* Whether the lateral ventricle had been opened into, the post-mortem examination did not prove conclusively. There was no collection of foreign matter in its interior; at the same time the softening had extended close to it.

due to the effects of simple pressure, and possibly to the subsequent secondary softening of the conducting fibres caused by it. On the twenty-first day the patient was seized with a rigor, followed by fever, and all the symptoms of meningitis, from which he died a week later.

(4) *Revelations of the Autopsy.*—The brain was practically everywhere healthy except over the area injured by the operation and in the membranes in the immediate neighbourhood. The meningitis was due to irritating matter from the interior of the wound flowing downwards between the layers of the arachnoid, and accumulating at the base of the brain. The local inflammation of the wound had opened out the parts, and separated the adhesions so as to allow the discharge to percolate into the cranial cavity, but not till three weeks after the operation.

The following case, though not in the motor area,* is of great interest from the size of the growth, its less usual site, and the complication of hæmorrhage, eventually fatal.

The patient was affected with cerebral symptoms extending over eighteen months, consisting of left hemianopsia, which could only be accounted for by a destructive lesion in the neighbourhood of the gyrus cuneus of the right occipital lobe, and locomotory disturbances, which appeared to be due to the pressure-effects of a tumour on structures below the tentorium, and implied a growth of considerable size. Operation having been decided upon, a U-shaped flap was raised, and a 1-inch trephine applied at 1 inch above the occipital protuberance, and the same distance from the middle line, beyond the limits of both the longitudinal and lateral sinuses, and the bone removed until an oval opening $2\frac{3}{4}$ by $2\frac{1}{2}$ inches was made, exposing a dura mater of a deeper hue than normal; section of this exposed the tumour, the outlying edges and base of which could not be reached in spite of further removal of the cranium, it was therefore incised and some of its softened, granular and fatty-looking contents forced out. Its size was now somewhat diminished, and the forefinger could be passed between the cranium and tumour, and by its aid the delicate cellular attachments that held the mass in place were felt to yield easily, enucleation now became possible, and the base was finally reached. By next drawing the finger gently but firmly towards the cranial opening, the tumour was torn nearly completely in two, and its outer half lifted out; then the inner part was separated from the falx with the help of the finger-nail and withdrawn. Inspection of the mass showed that the tumour had been entirely removed, and that its probable attachment had been towards the posterior border of the falx; the tumour was a spindle-celled sarcoma, weighing 5¼ ounces, measuring 3¼ inches long by 2⅓ inches wide, and being 8½ inches at its greater circumference. The falx was crowded over towards the left, and the tentorium depressed; two bleeding points were observed, one being in the region of the straight sinus, although not free enough for that vein, and probably belonging to the pedicle of the growth, while the other was apparently arterial. It being found that the hæmorrhage could be checked by direct pressure, the cavity was packed with 5 per cent. iodoform gauze, not too tightly, as it was assumed that the released brain would contribute additional pressure, and the ends of the strips were allowed, for easy extraction, to protrude from the lower angle of the scalp wound; the dura was partly united over the gauze by several loose sutures instead of being brought closely together, and the scalp wound closed with catgut sutures, a rubber drainage-tube being introduced under the skin up to the skull opening, and over these sublimated and iodoform peat bags were secured with gauze bandages. The patient soon showed symptoms of hæmorrhage, which could not be controlled by further packing, and death ensued thirteen hours later. Dr. Weir, in another case, would favour the application of hæmostatic forceps to the bleeding points, retaining them in place for twenty-four or forty-eight hours.

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* "Removal of a Large Sarcoma, causing Hemianopsia, from the Occipital Lobe of the Brain," by Dr. Birdsall and Dr. Weir: *New York Med. News*, April 16, 1887; *Annals of Surgery*, vol. vi. No. 2, p. 149.

Growths from the Dura Mater.

The above are cases of growths from the brain itself. Dr. Keen (*Am. Journ. Med. Sci.*, 1888,) has published a most interesting case of fibroma, weighing over three ounces, attached to the dura mater, which he removed successfully in a patient aged twenty-seven. The growth probably dated to an injury in childhood. It caused epilepsy, aphasia, complete hemiplegia, intense neuralgia, deafness, and great impairment of vision. Save for the eye and ear symptoms, all the others had passed away except slowness of speech and the epilepsy, and the last was much improved.*

Tubercular Growths.—These should only be attacked when there is good reason to believe that the growths are primary and single (p. 237). The following is one of the most interesting of Prof. Horsley's successful cases (*Brit. Med. Journ.*, Oct. 9, 1886).

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* Dr. Macewen (*Lancet*, August 11, 1888, p. 304) has published a case in which a tumour of the dura mater caused irritative lesions of the left frontal lobe. The patient was restored to perfect health, and died eight years later of Bright's disease.

A man, aged twenty, began, in January 1884, to have cramps in the left thumb and forefinger, these consisting of clonic opposition of the above-named digits, and occurring about twice a day for three months. The first severe fit occurred March 1884; the second in January 1885. Then followed a series of remissions of the twitchings, until in August 1885 commenced a series of fits occurring once or twice a week until admission in December 1885. The character of the fits was nearly always the same. They began by clonic spasmodic opposition of the left thumb and forefinger, the wrist next, and then the elbow and shoulder were flexed clonically, then the face twitched and the patient lost consciousness. The hand and eyes then turned to the left, and the left lower limb was drawn up. The right lower limb was next attacked, and finally the right upper limb. At frequent intervals every day the patient's thumb would commence twitching, but the progress of the convulsion could often be arrested by stretching the thumb or applying a ligature. Sensation was not affected. There was frequently severe headache, beginning at the occiput and shooting forward, especially to the right parietal region. The optic discs were normal. It was decided to explore the junction of the middle and lower thirds of the ascending frontal and parietal convolutions, a spot at which Prof. Horsley and Dr. Beevor had shown that the movement of opposition of the thumb and finger could be elicited.

On June 22, 1886, the seat of the lesion being determined by measurement, the 2-inch trephine was applied, and on removing the dura mater a tumour came into view. By further removal of bone the mass to which the dura mater was adherent was completely exposed. It stood out about $\frac{1}{8}$ inch from the surface of the brain, and was much denser than the brain substance. It appeared to be only $\frac{1}{2}$ inch broad, but as the brain substance all around it for more than $\frac{1}{2}$ inch appeared dusky and livid, the part apparently diseased was all freely removed. This was fully justified, since the growth spread widely under the cortex. Before closing the wound the centre of the thumb-area was removed by a free incision.* Numerous vessels were ligatured. The wound healed, and within two months the patient had regained everything, except that the grasp of the left hand was not quite so good as before.* There had been no fits since the operation. The tumour was composed of dense fibrous tissue, with two caseated foci, microscopical examination proving it to be tubercular.

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* This detail Dr. Hughlings Jackson and Prof. Horsley had resolved to carry out in the possible event of there being no obvious gross organic disease, in order to prevent, as far as possible, recurrence of the epilepsy.

Prof. Horsley (*Brit. Med. Journ.*, April 1887) has also removed, but with a fatal result, a tubercular tumour from the right lobe of the cerebellum, Death took place nineteen hours later, the patient having only partially recovered consciousness. Generalised chronic tubercle was found in the viscera. The operation was here performed as a *dernier ressort*. Mr. Bennett May (*Lancet*, April 16, 1867) removed a similar growth from the right lobe of the cerebellum of a child. The extreme bulging of the dura mater gave evidence of great intracranial pressure. The cortex appeared quite healthy, but at one spot palpation gave an ill-defined feeling of hardness. This spot being incised, the finger detected a hard mass nearly an inch below the surface. This was dug out with the handle of a small teaspoon. It was larger than a pigeon's egg, hard and horny outside and caseating in the centre. The hæmorrhage was trifling, but the patient sank from shock a few hours later. No autopsy was permitted. The above case is especially interesting from v. Bergmann's statement ("Die Chir. Behandlung Hirnkrankheiten": *Arch. f. Klin. Chir.* Bd. xxxvi. 1888, Hft. 4), that it is not possible to enucleate tubercular matter in the brain with a sharp spoon as in the skin or bones. Time alone will show whether the belief of this surgeon is correct, that operation in these cases may favour the dissemination of the tubercle, giving rise to tubercular meningitis.

Gummata.—The question of operation here can but rarely arise. Some have expressed the opinion that surgical interference is uncalled for. Thus, v. Bergmann (*loc. supra cit.*) has criticised Prof. Horsley for having operated on such a case. While no one will operate on a gumma of the brain till a sufficient trial has been given to mercury and potassium iodide,* there is no doubt whatever that a syphilitic lesion may reach a stage here as elsewhere, in which it has quite got beyond the reach of specific remedies. Such a lesion, if localisable and to be got at, should be attacked, because if left alone it will go on causing trouble indefinitely, and further the compression and wasting of adjacent nerve tissue which it will set up, will in time become irreparable.

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* Dr. Hughlings Jackson, in the discussion on Prof. Horsley's paper, said that it was proved that the "thumb centre"—*i.e.*, that part of the cortex in which the most special movements of the thumb are represented—had been cut out, by the fact that while the patient could move his thumb he had lost the most delicate movements of it. Even if the fits recurred, the patient was well rid of his tumour; if they did recur, Dr. Hughlings Jackson would advise removal of more of the cortex, believing it better to have some permanent paralysis than to be subject to fits becoming universal.

The most interesting case of operation in these cases is one of Dr. Macewen's (*Lancet*, May 23, 1885). In a patient aged twenty-five, there was left-sided motor monoplegia of arm and leg, preceded by muscular twitchings and tingling sensations, without loss of sensation, due to syphilis, and resisting prolonged treatment. A cortical lesion of the right motor area, in the upper half of the ascending frontal and parietal convolutions, with probable involvement of the paracentral lobule, was diagnosed. A crown of bone over an inch in diameter, with its anterior border reaching to a point about half-inch behind the auriculo-bregmatic line, and its upper margin reaching to within half an inch from the centre of the superior longitudinal sinus, was removed. Its inner surface showed osteophytes. The dura mater was thickened and rough. Crucial flaps of this being reflected, a yellowish opaque effusion covered the brain, obscuring the convolutions and bridging the fissure of Rolando. This was very friable and came away in minute portions. Towards the upper part of the opening the brain offered resistance on palpation. This sensation proceeded from the interior of the brain, in the direction of the paracentral lobule, a layer of brain tissue intervening between this more resistant structure and the finger. An incision being made through the upper part of the ascending parietal towards this firm structure, about two drachms of grumous fluid escaped. The resistance now disappeared, and cerebral pulsation was now, for the first time, feebly perceptible. The patient made a good recovery, regained sufficient power over the left side to enable her to walk two miles, and do her household work.

In the following case (Barton, *Ann. of Surg.*, January 1889) syphilitic necrosis of the frontal bone existed before the trephining; owing to this, the gummatous thickening of the dura mater found at the operation was fetid; this condition persisted, leading to hernia cerebri, and death about a month later. In this case, on incising the dura, characteristic gummatous deposit, yellow and cheesy, was discovered. It was very difficult to remove all this, as it was soft, friable, and firmly adherent to the walls of a cavity which it seemed to have hollowed out on the upper surface of the anterior lobe. The paralysis of the right arm and leg improved at first after the operation.

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* The American method of pushing this drug in large doses at frequent intervals in milk (*Arch. of Medicine*, New York, Oct. 1884), is especially applicable here.

Cysts.—While the cerebellum appears prone to these formations, they occasionally occur after injury over the motor area, as in the two following cases (Macewen, *Brit. Med. Journ.*, Aug. 11, 1890):—

Epilepsy (Jacksonian) induced by Focal Facio-lingual Lesion—Removal of Cyst from Brain—Cure.—A man, aged twenty-two, had epileptiform convulsions, each lasting from two to three minutes, with an average of over 100 in 24 hours. The convulsions were limited to the tongue, right facial muscles and platysma. When they subsided the parts remained paralysed. Consciousness was retained. Eight years previously he received an injury to the head, after which his right arm became weak, though he was able to work. It was clear that an irritating focal lesion existed, confined to the base of the ascending convolutions, causing a Jacksonian epilepsy. The only question was, whether the base of the ascending parietal was involved as well as that of the ascending frontal. The contraction of the platysma on the opposite side is asserted to be induced by stimulation of the ascending parietal. Dr. Whitelocke suggested, however, that the platysma is often supplied by the facial, so that a single lesion in the base of the ascending frontal would account for the whole phenomena. At the operation, in the lower part of the ascending frontal, a cyst about the size of a filbert was found situated partly in the cortical and partly in the white substance of the brain, surrounded by a narrow zone of encephalitis. In manipulating the medullary substance during the removal of the cyst, the patient, while under chloroform had a convulsion similar to those prior to the operation. The convulsion ceased with the removal of the cyst, and he never had another. The wound healed firmly under one dressing, the paralysis of the facial muscles soon disappeared, and he has since been constantly at work. The power of the right arm has also increased. Possibly the cyst might have caused, indirectly, slight pressure on, or had set up inhibitory action of, the middle part of the ascending frontal.

In another case in which brachio-crural monoplegia was present, with late rigidity, these dating to an injury eight months before, Dr. Macewen removed a large thick-walled, subdural cyst, containing clear fluid, which was pressing on the motor convolutions, together with a spiculum from the inner table, which had penetrated the brain. The paralysis, with the contraction of the muscles, passed off to a great extent. The patient could neither walk nor stand before the operation, afterwards he could run about, and use his hand well, though there was still paresis in both limbs.

Questions arising before Attacking a Cerebral Tumour.—The chief of these are: (A) The existence of a growth. (B) The site of the growth. (C) The depth of the growth. (D) Is it single or multiple? (E) Its nature.

(A) *The Existence of a Growth.*—The diagnosis here will usually be accurately made by a physician.

(B) *The Site of the Growth.*—Dr. Seguin (*Amer. Journ. Med. Sci.*, Aug. 1881) thus states what he believes to be bases of a reliable diagnosis here.

I. There are parts of the brain the lesions of which produce uncertain or no localising symptoms. Growths here produce only general symptoms of cerebral disease. These areas are: (*a*) the frontal lobes strictly speaking, except the caudal end of its external gyri, especially the second and third; (*b*) the apex and base of the temporal lobes on both sides, and the whole of the right lobe; (*c*) the external and basic aspects of the occipital lobes; (*d*) parts of the parietal lobes; and (*e*) the central ganglia.

II. Tumours of the Motor Area.

(*a*) Tumours of the caudal end of the third frontal gyrus (on the left side in dextrous persons) produce at first slowness in speech and paroxysmal motor aphasia. Their extension towards the rest of the motor zone causes paresis and convulsive movements of the tongue, face, and upper extremity on the opposite side, later still these symptoms, motor aphasia, spasmodic movements and paralysis of the tongue, face, and upper extremity become more frequent, and finally permanent; with occasional spasms. (*b*) Tumours of the basal ends of the pre- and post-central gyri, cause at first convulsive movements or paresis, or both, of the opposite half of the tongue; later, paroxysmal motor aphasia, spasms and paresis of the face and upper extremity; last, complete paralysis of tongue, face and upper extremity, and permanent aphasia, with occasional convulsions. (*c*) Tumours of the caudal end of the second frontal gyrus, where it becomes confluent with the lower third of the pre-central gyrus, produce at first paresis with convulsive movements (or *vice versâ*) of the facial muscles of the opposite side; later, the same and more or less motor aphasia, paresis of one-half of the tongue, paresis and spasm of the upper limb (especially the fingers); lastly, permanent paralysis of the face, half the tongue and hand, permanent aphasia and occasional spasms. (*d*) A tumour starting in the lower middle third of the pre-central gyrus first reveals itself by spasm and paresis of the opposite thumb and fingers (and hand and forearm occasionally), later, the irritative and destructive symptoms appear in the face and tongue, and more or less marked aphasia occurs; the paresis of the hand and forearm becoming complete paralysis. A peculiarity of lesion of this centre is pronounced numbness and slight tactile anæsthesia. (*e*) Tumours of the upper middle third of the pre-central gyrus (and perhaps of the post-central also) early cause symptoms in the muscular apparatus of the upper arm and shoulder. Later, the spasm and paresis extend to other parts. (*f*) Tumours of the upper third of the pre- and post-central gyri, and of the paracentral lobule, at first cause symptoms, convulsive and paretic, of the thigh, leg or foot. Later, by extension of the growth, there are symptoms in the arm and hand, rarely in the face, probably never aphasia.

III. Tumours of the Sensory Zone.—(*a*) A patient presenting, besides the general symptoms of an intra-cranial growth, such a specific symptom as verbal deafness, without marked hemiplegia, hemispasm, or hemianæsthesia, probably has a tumour involving the left superior or dorsal temporal gyrus, or its subjacent white fasciculus. The symptoms produced by extension would be mostly sensory—*e.g.*, paræsthesiæ, loss of muscular sense, and, later, anæsthesia of parts on the opposite side of the body. (*b*) A patient who has headache, vomiting, choked disc, dulness approaching to stupor, increasing hemianæsthesia, with lateral hemianopsia (dark half-fields on same side as anæsthesia), without hemispasm or hemiplegia, quite certainly has a tumour in the white substance of the occipital lobe. (*c*) If with the above general symptoms of cerebral tumour we find lateral hemianopsia almost alone as a localising symptom—*i.e.*, without hemispasm, hemiplegia, and hemianæsthesia—there is almost certainly a tumour on the middle or inner aspect of the occipital lobe, opposite to the dark half-fields, compressing and destroying the cuneus. The symptoms to be expected from the extension of such a tumour upwards are, weakness and even paralysis of the lower extremity of the same side as the dark half-fields; and from its downward growth, symptoms of injury to the cerebellum and the optic lobes.

(C) *The Depth of the Tumour*—*i.e.*, is the tumour cortical or sub-cortical? Dr. Seguin thus sums up on this point. As regards the motor zone, in which, as a rule, it is possible correctly to localise a tumour, the question is somewhat simplified, and may be stated as a diagnosis of probability with many chances of error. In favour of a strictly cortical or epi-cortical lesion are these symptoms, none of them having specific or independent value. Localised clonic spasm, epileptic attacks beginning in local spasm, followed by paralysis; early appearance of local cranial pain, tenderness, and increased local cranial temperature. In favour of subcortical tumour, local or hemiparesis, followed by spasm; predominance of tonic spasm; absence, small degree, or very late appearance of local headache, and if tenderness to percussion, normal cranial temperature.

(D) *Is the Tumour Single or Multiple?*—When the symptoms of cerebral tumour occur in an individual who already presents signs of tuberculosis, the probability that the cerebral secondary deposit is multiple will be very great, and for this and other considerations an operation will be unadvisable. When symptoms indicating lesions of different cerebral centres are present, and especially when symptoms of basal disease are combined with those characteristic of tumour of the motor or sensory zones, the probability of double or multiple lesion will amount almost to certainty. *E.g.*, should a patient present motor symptoms in one hand and side of face, spasm and paresis, with headache and perhaps choked disc, justifying the diagnosis of tumour in the pre-central gyrus; if in such a patient marked anæsthesia, hemianopsia, or verbal deafness developes, there is ground for suspecting the presence of another tumour, or several tumours, involving the posterior division of the internal capsule in the occipital lobes or the left first temporal gyrus; or, if in a patient with symptoms of tumour in the pre-central gyrus there should intervene dysphagia, symptoms of irritation of vagus and spinal accessory, with bilateral paresis of the extremities, the presence of an additional growth in or on the medulla is probable.

(E) *The Nature of the Tumour.*—Some help as to the varieties of growth most likely to be met with will be gained from the following table (Hale White, *Guy's Hosp. Rep.*, 1886*).

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* Dr. Seguin (*loc. supra cit.*) groups together Dr. White's cases and those of Bernhardt:—

Of a hundred cases of cerebral tumour the proportions were as follows :—

Tubercle	45
Glioma	24
Glio-sarcoma	2
Sarcoma	10
Carcinoma	5
Lymphoma	1
Myxoma	1
Cyst	4
Gumma	5
Doubtful	3
	100

Of the forty-five cases of tubercle, the cerebrum was affected in twenty-two, the cerebellum in twenty cases. The growth was multiple in nineteen, and single in twenty-four cases. In all the forty-five cases one or more other structures than the brain were affected. Dr. White concludes that not more than three tubercular cases were likely to be benefited by operation, and even in these the other organs were tubercular.

Of the twenty-four cases of glioma, of ten only could it be said that they were not infiltrating. The cerebrum was the seat of the disease in thirteen cases, the cerebellum in four. In one case

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Nature of tumour not stated	133
Tubercular tumours	137
Gliomata	76
Sarcomata (including cysto-sarcomata)	75
Hydatids, cysticerci, and echinococci	30
Cysts	27
Carcinomata	24
Gummata	21
Glio-sarcomata	14
Myxomata (including myxo-sarcomata)	12
Osteomata	6
Neuromata	4
Psammomata	4
Papillomata	4
Fibromata	3
Cholesteomata	2
Lipomata	2
Erectile tumours	2
Dermoid cysts	2
Enchondromata	1
Lymphomata	1
	580

The large proportion of the fifth heading (hydatids, &c.) must be attributed to their frequency on the Continent. In England and America they are almost unknown.

there were multiple gliomata in the brain, and in two others there were growths in other parts of the body.

Of the ten cases of sarcomata several affected the dura mater in inaccessible positions; of the five cases which attacked the brain only, one alone could have been removed with any prospect of success. Of the remaining tumours none of the carcinomata or glio-sarcomata were amenable to treatment. Of the four cases of cyst one could certainly, and another possibly, have been operated upon; the myxoma was, and the lymphoma was not, amenable to operation, and of the three doubtful cases, two could have been operated on. Dr. White's summing up is as follows:—"Thus we see that out of one hundred cases of tumour of the brain, ten might certainly have been operated upon, and four additional ones might possibly have been, so that in 10 per cent. of our cases we can hold out some hope of operative relief to our patients, provided that a correct diagnosis of the position of the growth be made, even so late as shortly before their death, whilst of course earlier in their histories many others might have been operated upon with a good prospect of success."

In a certain number of cases of tumour of the brain the bones of the skull will be found, as the result of increased pressure, very light, thin, roughened like sand-paper on the inner surface, but without any softening (Hale White, *Guy's Hosp. Rep.*, 1886). If this observation is confirmed, it is obvious that it inculcates the need of extra care in trephining, while it points to the value of inspecting carefully the inner surface of the crown removed.

Chief Difficulties and Dangers in Operations in Cerebral Tumours.—Some of these are enumerated now; they will be more fully dealt with in the next section:—

(1) Sufficient exposure of the growth. (2) Embarrassments with the anæsthetic. (3) Hæmorrhage. (4) Difficulty in detecting the growth. (5) Difficulty in isolating the growths.

(1) Sufficient exposure of the growth.

(2) Not only may much bone require removal (as in the case recorded, p. 229), but the patient's condition, from a tendency to coma, failing pulse, and respiration, aided by the effects of the anæsthetic (p. 154), may seriously embarrass the surgeon by cutting short the time needful for sufficient removal of the cranial bones.

(3) Hæmorrhage.

This may be met with on division of the dura mater from sinuses or branches of the middle meningeal artery which cannot be avoided. The means of treating such hæmorrhage have already been given at pp. 158, 178. Far graver hæmorrhage may have to be encountered on removing the tumour itself, as occurred in the cases at pp. 225, 230. The best means of arresting this is probably, first, firm pressure with an aseptic sponge, followed by careful packing of the cavity with strips of sal alembroth or iodoform gauze, the ends being left long for removal, then uniting, as closely as possible, the dura mater with chromic gut sutures, and the scalp with silver sutures over the gauze, a drainage tube of adequate size having first been adjusted, with its distal end quite up into the cavity. This means failing, Dr. Weir's suggestion to leave Spencer Wells' forceps *in situ* should be tried, but the frailness of the tissues on which they hold, and the need of keeping the patient's head absolutely still as long as these forceps are in position, are points which will not be lost sight of.

OPERATIVE PROCEDURES ON THE BRAIN, CHIEFLY FOR THE REMOVAL OF GROWTHS.*

Preparation of the Patient.—The day before the operation the patient's head is shaved, washed with soft soap and then ether; next, the position of the lesion is ascertained by measurement, and marked on the scalp. The head is then covered with lint soaked in carbolic-acid solution (one in twenty), oil silk and cotton wool, being thus thoroughly carbolised for at least twelve hours before the operation. Finally, the patient has the usual purgative administered the evening before, followed by an enema on the morning of the operation.

Anæsthetic.—A hypodermic injection of a quarter of a grain of morphine† is given, and then chloroform is administered. The object of giving the morphine is twofold, in the first place it allows of the performance of a prolonged operation, without the necessity of giving a large amount of chloroform, the amount actually used in an operation lasting two hours being very small.

The second reason is perhaps the more important, that this drug causes well-marked contraction of the arterioles of the central nervous system, and that consequently an incision into the brain is accompanied by very little oozing, if the patient be under its influence. Prof. Horsley has not used ether in men, fearing that it would produce cerebral excitement; chloroform, on the contrary, producing well-marked depression. If there existed any heart complication, the above theoretical considerations would be disregarded in favour of the safer anæsthetic.*

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* Many other operations on the brain—*e.g.*, for abscess, removal of bullets—have been already fully considered. Several instances of removal of growths have also been given in the preceding pages. Prof. Horsley (*Brit. Med. Journ.*, Oct. 9, 1886, and April 23, 1887) first insisted on the majority of the details above given.

† In one case, a child of four, one-twentieth of a grain was found amply sufficient. The advisability of a preliminary injection of morphia has been a good deal disputed. When it is contra-indicated, ʒj–ʒij of the liquid extract of ergot may be given half an hour before the operation, as advised by Dr. Keen.

Treatment of the Wound.—The high mortality accompanying trephining being largely due to septic meningitis, strict antiseptic precautions will alone give safety.

Line of Incision.—Prof. Horsley disapproves of the ordinary crucial incision as inconvenient at the time, as the four flaps have to be held out of the way, and later on their point of meeting, a weak spot, may aid the formation of a hernia cerebri. If, on the contrary, a semilunar flap be raised, it can simply be thrown back and requires no more holding; later on, the advantage of raising such a large flap, which can be laid down like the lid of a box, will be obvious since, being continuous throughout, it offers plenty of resistance to the upward-pushing brain, which the point of meeting of four cross-cuts can never do; this indeed, on the contrary, favouring the very thing one wishes to avoid. The following details with reference to raising the flap will not be out of place here:—(1) All the parts superficial to the periosteum must be raised with the flaps. (2) The curve must be a shallow arc to avoid cutting collateral vessels. (3) It must be so drawn as not to divide the main arterial branches supplying that part of the scalp. The periosteum should be reflected by a crucial incision from an area corresponding to the first trephine hole, and subsequently as more bone is cut away. As the flap method, with the above great advantage, produces freer hæmorrhage, some have advised tying a rubber band tightly round the head on a level with the occipital protuberance, after the plan mentioned at p. 151. This method, though sometimes controlling the bleeding well, is somewhat uncertain. The use of several of Spencer Wells' forceps, and pressure with sponges out of hot 1–2000 perchloride solution will arrest the hæmorrhage.

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* Attention is also called to the startling rapidity with which a patient, who has roused up in the middle of one of these prolonged operations, can be sent off again, in a moment, with only a few whiffs of the drug, and that thus it is very easy to give too much in a brief space of time. Prof. Horsley expresses a strong opinion that this sensitiveness to the action of the anæsthetic is more marked when the dura mater is opened.

It is usually important to indicate on the bone itself the site of the first trephine-opening. The previous careful outlining of this on the shaven scalp will be of no avail after the flap has been lifted away. Measuring instruments have to be used again, perhaps without disinfection. Therefore, to mark the position of a scar, or the fissure of Rolando, Dr. Keen (*loc. supra cit.*) has advised previous nicking of the bone with a small gouge through one or more small incisions in the scalp.

Removal of the Bone.—The cranial opening should always be sufficiently free. A cramped opening is certain to defeat the object of the operation in the case of a growth. Where exploration has to be made, the most rapid way is to make a couple of holes with a 2-inch trephine at the opposite extremities of the area to be removed, then to cut half through the sides of such an area with a Hey's saw, and, finally, to complete the division with a powerful bone-forceps,* or the intervening bone may be nibbled away with Hoffman's forceps. Dr. Keen (*loc. supra cit.*) points out that the brain allows of gentle pressure very readily, and that the finger can be inserted for purpose of examination an inch all round the opening. Where it is possible to preserve the dura mater intact, the portions of bone removed should be preserved in hot aseptic lotion, and, at the end of the operation, placed between the skin and dura mater, having been previously divided into small fragments as advised by Dr. Macewen.†

Treatment of the Dura Mater.—This should be incised round four-fifths of the circumference of the area exposed at ⅛ inch distance from the edge of the bone, so as to render it possible to stitch the edges together afterwards. The dura mater is best opened first by incision with the scalpel, and then by blunt-pointed curved scissors, great care being taken not to wound the parts beneath. The main branches of the middle meningeal are best secured by ligature before they are divided.

Treatment of the Brain.‡—If this, after incision of the dura mater, bulges very prominently into the wound, it indicates pathological intra-cranial tension, and probably a tumour.* The next point is the colour of the brain. Prof. Horsley believes that the existence of a slightly yellowish tinge, or, possibly, the contrary condition—viz., lividity, will indicate a tumour beneath the cortex in the corona radiata. The condition of the vessels and of the peri-vascular lymphatics should next be investigated, and particular note taken of any yellowish-white patches in the walls of the latter, indicating old mischief. Alterations in the density of the brain must next be observed, but it must be remembered that cerebral tumours, situated beneath the cortex, are scarcely to be detected, save by exploratory incision. Dr. Weir (*loc. supra cit.*) thinks a needle of very little value in exploration of a growth. A tumour too soft to be detected by the finger will not be recognized by the needle. Furthermore, two cases have come to Dr. Keen's knowledge in which fatal hæmorrhage followed its use. Careful palpation and the insinuation of the finger-tip under the trephine-opening are preferable.

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* In his second paper (*Brit. Med. Journ.*, April 23, 1887), Prof. Horsley recommends, as the most rapid method, first, taking out an inch disc with a trephine, and then cutting out a piece of the size required with a circular saw, mounted on a Bonwill's surgical engine (Mayer & Meltzer), the separation being completed with very powerful bone-forceps.

† Though the vitality of the fragments has invariably been perfectly preserved. Prof. Horsley has not, so far, observed much ossification of the cicatrix. Where a large area of bone has been removed, a perforated celluloid cap, light, but very strong, is recommended.

‡ Any of the dura mater which is adherent to the tumour is usually much

Hæmorrhage.—In removing a portion of the brain, or a tumour, the bleeding which has been so much dreaded will usually cease if the wound be plugged for a few minutes with a piece of sponge. The value of a preliminary injection of morphine has already been alluded to, and Prof. Horsley further points out that, owing to the fact of the main vessels remaining in the pia mater they can be raised from the brain, and especially out of the sulci, so as to allow of the subjacent brain being removed: other means of arresting hæmorrhage are boiling water, cooled to 105° or 110°;

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altered. If the mischief is recent, the membrane will be simply highly vascular. In advanced cases it may be yellowish, and in some instances, on separating it from the growth beneath, it is found to be of a dirty reddish colour. In all cases where it is adherent the dura mater must be freely excised.

* In some cases where there is abundant evidence of intra-cranial tension a growth may be present, but out of the range of the operation. Thus, in a case in which Dr. Weir (*Ann. of Surg.*, June 1887) trephined over the upper part of the right fissure of Rolando for spasms in the left limbs and loss of power in the left leg, no growth was found. Death took place ten weeks later, and a spindle-shaped sarcoma apparently originating in the pia mater was found springing from the lower surface of the left cerebellar lobe, displacing the medulla forwards to the right, and invading the fourth ventricle. Dr. L. S. Pilcher (*Ann. of Surg.*, March 1889) relates the case of a man who presented symptoms which, though not very definite, were not inconsistent with the existence of a growth in the angular gyrus, or its immediate vicinity, being the site of a previous injury. Trephining being performed, the dura mater and brain projected so strongly that, after the former had been reflected, a rent took place in the cortical portion ½ inch deep. No growth was found, and the patient died thirty-eight hours later with pulmonary œdema. The autopsy showed an infiltrating glioma in "the anterior half of the left hemisphere."

cocaine 10 per cent. (Keen); fine catgut ligatures tied without jerking, and not too tightly. If any bleeding vessel is not well within reach, the opening must be enlarged to get at it. Where other methods fail Spencer Wells' forceps may be left on for 36 or 48 hours; but the patient must be carefully watched, lest his restlessness cause the friable tissues to give way, or inflict damage on his brain. A meningeal branch should be underrun before it is cut. Wounds of the large venous sinuses have already been alluded to (p. 158).

Incision of the Brain.—The cuts in the cortex must be made exactly vertical to the surface, and directed into the corona radiata where necessary, in such a manner as to avoid damage to the fibres coming from the portions of cortex, and surrounding the seat of operation. If possible, portions of each centre should always be left, so that the representation of its movements may never be totally destroyed. A portion of brain removed does not leave, as might have been supposed, a permanent gap with vertical sides, for, in a very short time, the corona radiata forming the floor of the pit bulges almost to a level with the surrounding cortex.

*Difficulty in Detecting the Growth.**—This may arise from several causes. (1) The want of distinctness in the growth—in other words, its close resemblance to brain substance.† (2) By the growth being overlaid by normal brain substance (p. 225). (3) By change in the growth—viz., hæmorrhage from its thin-walled vessels, and later on caseation of the coagula, these conditions being likely to puzzle the operator.

Difficulty in Isolating the Growth.—(1) This may be due to the absence of a capsule, and thus to the infiltration of the surrounding parts. Now that gliomata, owing to the operative attacks which will be made upon them, are of such practical importance from a new point of view, this question of a capsule is a very weighty one. It seems to be a disputed point. Thus, in Dr. Bennett's and Mr. Godlee's case the glioma was found to be "thinly encapsuled, but quite isolated from the surrounding brain substance." Not so, however, is it in many other cases. Indeed, the chief pathologists speak decisively on this point. Dr. Fagge (*loc. supra cit.*) wrote: The substance of glioma "is always continuous with that of the surrounding cerebral tissue, for there is never a capsule,* as with some sarcomata. Indeed, it often assumes the form of the part in which it grows, so that one might imagine the corpus striatum or the thalamus, or some particular convolution, to have become swollen to three or four times its usual size."

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* I have confined myself here to gliomata, the commonest of cerebral tumours.

† "A glioma may be of a pinkish-red colour, or it may look so exactly like the normal brain-substance that a microscope is required to demonstrate its presence."—Dr. Fagge, *Medicine*, vol. i. p. 523

(2) Another source of doubt in telling when a glioma not encapsulated has been isolated, arises from the fact that, as pointed out by Dr. Fagge (*loc. supra cit.*), these growths, in common with all the less circumscribed form of cerebral tumours, are apt to set up morbid changes in their immediate vicinity, usually of the nature of softening, partly inflammatory, partly œdematous.

Excision of Cortex Centres for Epilepsy.—As this is an operation which may be tried in the future, it will be well to mention one case. Dr. Keen, of Philadelphia (*Am. Journ. Med. Sci.*, Oct. and Nov. 1888), successfully excised the centre for left wrist and hand in an epileptic whose fits always began in the left hand. The patient, aged twenty, had had a fall on his head when thirteen. There were no definite traces of this, and exploration of the part which had possibly been struck detected nothing abnormal. Each fit invariably began in the left arm and fingers. The thumb and fingers became rigid and extended, widely separated, the hand and forearm in a right line, and the elbow flexed. Usually both legs were next attacked, the left usually before the right, and crossed in front of it; next the face was attacked, the mouth being drawn to the left. After this the convulsions became general.

The fissure of Rolando being marked on the scalp in order to indicate it on the skull itself, two small incisions were made at the ends of the line, and with a bone gouge two small circles were made through these on the skull. A 1½-inch trephine was then applied with the centre-pin ⅛ inch behind the fissure of Rolando, the lower margin of the trephine being about ¼ inch above the temporal ridge. The crown was placed in 1–2000 bichloride solution, carefully kept at T. 100°–105°. The bone and dura mater both appeared normal; no bulging was observed, and the pulsation was regular. The dura was now incised. The pia was very much infiltrated with serum, producing an œdematous layer much obscuring the brain tissue, especially the sulci over all this area. Two convolutions, running obliquely downwards and forwards, crossed the trephine opening, while at the anterior border a third convolution, with, apparently, a like direction, came into view. An attempt was made to determine which was the Rolando fissure by examining the depths of the sulci, but as both were about 1 inch deep, this gave no clue. By the cystometer (disinfected) the position of the fissure of Rolando was re-determined. This ran in the middle of the three convolutions. To determine the seat of the hand-centre a faradic battery was used, the ends of the wires being wrapped in borated cotton dipped in bichloride solution. Stimulating the two posterior convolutions gave no results. When the anterior one of the three was touched the hand instantly moved, the wrist and fingers being extended. Above this centre were the shoulder and elbow centres, and below that for the face. The opening in the skull was now enlarged, and the portion of the hand-centre about 1¼ inch long, as ascertained by the battery, was then incised above and below with a knife, the lower incision being ⅝ inch above the temporal ridge. The lower end of the portion to be removed was then lifted up, and the loosened convolution cut away with scissors. While this was done, no movement was perceived. The battery wires were now again applied. At the remaining part of the convolution above, flexure and extension of the left elbow, elevation and abduction of the shoulder were noticed. Touching the part remaining below produced an upward movement of the whole left face. The large vessels in the brain were extremely gently tied with chromic gut, and oozing checked by hot water and cocaine (4 per cent.). The dura mater was sewn with chromic gut, two bundles of horsehair being placed beneath it. The disc of bone and some fifteen pieces removed were replaced on the dura. Soon after the patient recovered from the ether he had a fit, but the hand did not move. The patient made a good recovery, and a month after the operation the skull was as firm on one side as the other, with very slight, if any, irregularity where the pieces of bone were replaced. The fits were greatly diminished, and only of a momentary character, practically *petit mal*. There is no convulsive movement whatever; the hands and wrist were as before. Seven weeks after the operation the patient wrote that motion was returning in the left hand. Dr. Keen thought that by "compensation" it was nearly certain that in time control over the left hand would be regained through the other hand centre.

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* The glioma "is distinguished by having no capsule, but merging indefinitely into the tissue around. It is firm and tough, otherwise very like brain-tissue, but more pellucid."—Dr. Wilks and Dr. Moxon, *Path. Anat.*, p. 239.

The above remarks refer to attempts to remove certain definitely localised small centres. The following words of Dr. Macewen

(*Brit. Med. Journ.*, Aug. 11, 1888) have an important bearing on this matter, and, from his wide experience, carry great weight. "Can the motor area be removed in large pieces with immunity from serious consequences? If this region be of such psychical importance to movement, and destructive cortical lesions in it are followed by secondary degeneration of the motor tracts, then excision of these areas will necessarily induce permanent paralysis, late rigidity, and ultimate structural contracture. The removal of large wedges from the brain, especially in the motor centres, will produce serious effects upon the brain as a whole, causing, during cicatrisation, a dragging and displacement of the neighbouring parts, with final anchoring of the cerebrum to the cicatrix.* . . . . In the presence of a stationary cicatrix, or a slow-growing neoplasm in the motor area, occasionally producing fits, few would attempt the removal of such a large wedge of the motor region as to induce permanent hemiplegia. Even when the fits are much more numerous and aggravated, it is serious to contemplate the production of hemiplegia while attempting the cure of the fits. No doubt these epilepsies, when long continued, especially in early life, are apt to lead to great and extensive instability of the motor cortex, so as to warp the whole cerebral function, and ultimately involve life itself. Still, how much better is the cure by the removal of a large wedge, involving the greater part of the motor area? How many people would submit to have their upper and lower limbs on the same side of the body amputated at their proximal points—for this is what the hemiplegia amounts to—in the process of cure of their fits. Numerous epileptics have been asked the question by me, but none have expressed their willingness to undergo such a cure. Even had they done so, the circumstances would require to have been exceptional to induce one to hazard the life of the patient for so poor a result. . . . . Nor is the removal of very large tumours and large wedges of brain free from immediate peril to life. In several instances operated on elsewhere death has ensued—one while the tumour was being removed, and one immediately after the completion of the operation."

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* "*Anchoring of the Brain and some of its Consequences.*—When injury has been inflicted on the surface of the cerebrum, followed by plastic effusion and cicatricial formation, the superficial substance is apt to become soldered to the membranes when these remain intact, which in turn may be soldered to the skull, or, in the event of their detachment, the brain may become directly adherent to the bone. Thus, the surface of the brain becomes anchored or soldered to its rigid walls. It has no longer the free play within its water bed to expand and contract according to the varying states of the circulation. Each variation produces a dragging of the brain at the spot, and through it the whole hemisphere at least is affected. Any sudden physical effort pulls on the brain, producing a slight shock, a momentary disturbance just as if the cerebrum had received a blow. Vertigo results. People affected in this way cannot rise up quickly, or perform any sudden movement of the body or head, without experiencing a sensation of giddiness, which sometimes causes them to drop. Following upon this, the grey matter of the cortex, immediately surrounding the cicatrix, by the incessant movement is apt to become unstable and produce fits. Some cases of traumatic epilepsy are thus caused. Further, if the cortical irritation be continued, encephalitis is occasionally produced, often appearing in a chronic form and long remaining so, though susceptible of being lit up into an acute affection, If the temperature remain high, active interference is apt to induce an extension of the encephalitis. Operation in such cases should be, when possible, postponed. The disregard of this advice has, to my knowledge, in one instance, hastened the fatal issue, encephalitis becoming rapidly general."

Closure of the Wound.—All bleeding having stopped, the pieces of bone are placed on the dura mater, the cut dura mater is sutured with fine catgut, room being left for drainage, and the flap is secured with medium-sized silk and horsehair sutures. Prof. Horsley removes the drainage-tube, which is to be inserted at the most dependent part of the incision (as the patient lies in bed) at the end of twenty-four hours, and makes firm but gentle pressure over the centre of the flap. The tube serves to remove the steady oozing of blood and serum from the cut surfaces, which takes place during the first twenty-four hours, and its removal at the end of this time is advised, in order to allow of a certain amount of tension of wound exudation to occur within the cavity, this tension not interfering with primary union if kept within proper bounds, while it secures pressure on the brain which is tending to extrude, and serves, when the wound is finally healed, to separate the skin flap from the brain beneath by a cushion of soft connective tissue. If, after the removal of the tube, there is much pain and throbbing in the wound, and the union threatens to break down, the edges must be sufficiently separated with a probe, gently used, in the track of the drainage-tube.

Causes of difficulty in cerebral operations and of their not doing well:—

1. The anæsthetic not being well taken (p. 239).
2. Hæmorrhage (pp. 239, 243).
3. Shock (p. 232).
4. Œdema of the lungs.—This is especially likely after prolonged operations, where it has been needful to give ether, and in cases where, for some time before the operation, the patient has been practically bedridden, and his functions at a very low ebb.
5. Hernia cerebri.—This may occur in two ways: (*a*) Immediately, during the operation, in a case where there is much

evidence of intra-cranial pressure, and where it has not been possible to remove the cause. Thus, in Dr. Pilcher's case (*loc. supra cit.*), the projecting cerebral mass was so great in volume and so tense that there was no possibility of returning it within the cranial cavity, nor of covering it by the usual flaps. Accordingly it was sliced down to the level of the bone. (*b*) Later on, it may point to unrelieved tension, as in a case of mine of cerebral abscess to which I have alluded and in which a good recovery took place after evacuation of the re-collection of pus. In such a case constant pressure with the aid of a piece of sheet-lead, notched or perforated for the drainage tube will be found most useful. In other and more numerous cases a later hernia cerebri points to septic changes. Dr. Macewen thus points out another cause: "It is true that round many neoplasms there is a zone of encephalitis, and should this be extensive and of the nature of red softening, false hernia cerebri is prone to form. It was supposed that false hernia cerebri was entirely due to decomposition, many recent writers averring that it cannot occur unless when operations are conducted non-antiseptically, basing their belief on experimental investigations conducted on brains in a physiological state. Had they concluded that the formation of false hernia cerebri, after operations, was principally caused by decomposition, and always so when it occurred after operations on a physiological cerebrum, they would have been right. The consistence of false hernia cerebri is identical with red softening of the brain, occurring in idiopathic affections in which there had been no operation. In one instance, in which trephining was performed for the relief of pressure causing total hemiplegia, and when the symptoms indicated either acute encephalitis or abscess, or both, the moment the dura mater was opened a large mass of encephalitis protruded through the membranes, forming a false hernia cerebri on the surface of the scalp. This encephalitis was not occasioned by septic matter introduced through a wound, as it occurred the moment the wound was made. Around neoplasms red softening sometimes exists, and interference might possibly occasion an extension of the affection, though were the operation conducted with strict antiseptic precautions, the possibility of its formation would be reduced to a minimum. With this exception, there has been no false hernia cerebri after any of my operations."

6. Septicæmia.
7. Impossibility of complete removal.
8. Recurrence.

In some cases where the growth has not been found, or where its complete removal has not been possible, the symptoms have been materially improved by the relief given to the pressure. Thus, in the *Lancet* of April 7, 1888, a case under the care of Mr. F. A. Heath is reported, in which, though the tumour was not removed, owing to adhesions to the anterior fossa, the benefit derived from the relief given to the pressure was most decided. "The patient recovered promptly from the operation, with the formation of a hernia under the healed scalp, shortly after regained a considerable power of motion in the paretic limbs, remained free from epileptic attacks for over two months, and for a long time was rid of the headache. He was seen thirteen months after the operation, and though completely blind could walk about very well. Of late the headache had returned, and the epileptic attacks had become more frequent."

The following case of Fischer's, of Breslau (*Centr. f. Chir.*, Bd. xxix. 1889), bears on the same point. A patient was admitted with complete paralysis of the right arm, which had been coming on for a year, and very severe headache on the left side. The right leg was also weaker, dragging a little in walking. The left precentral convolution was exposed, but no trace of a tumour could be found. The patient experienced great relief from the operation. The headache was gone, the arm paralysis was less, and the convulsions ceased. Five months later the patient began to complain again, the paralysis of the right arm and leg having increased, and epileptiform seizures being of daily occurrence. He urged repetition of the operation. The skull being again opened at the same place, a red lobulated tumour soon bulged up. It was shelled out piecemeal with the finger, as it continually broke off on pulling, severe hæmorrhage resulting. The growth was also firmly adherent to the dura. The hole in the brain was lightly plugged with iodoform gauze. All symptoms of growth were again in abeyance. Two months later the patient began to complain again, and now a growth grew through the trephine opening. The autopsy showed that the growth in the brain had been completely removed. The recurrence started from the dura. It was a vascular round-celled sarcoma.

CHAPTER IV.

OPERATIONS ON THE FACE.

OPERATIONS ON THE FIFTH NERVE.

UNDER this heading will be given the operative treatment of facial neuralgia, including neurotomy, neurectomy, and nerve-stretching. While the results in none of the three are really permanent, in the first they are certainly the shortest-lived. It is, perhaps, too early to estimate precisely the respective value of neurectomy and nerve-stretching of the fifth nerve. In the first place, no comparison can be made between stretching a nerve like the sciatic (one from which most of our experience in the operation has been derived) and the fifth nerve. In the sciatic, stretching alone is available, as the nerve is a mixed one. Again, the course of the two nerves is widely different. The sciatic runs amongst soft parts, and is readily reached and stretched. The fifth nerve would be readily ruptured by anything like the force which is usually applied to the sciatic; furthermore, it runs in its passage from the skull through bony foramina, and, in the case of two of its divisions, through bony canals as well. In the second place, in nerve-stretching, even more than in neurectomy, the published results seem to me to be unreliable, cases having here been much too often published without sufficiently prolonged watching. At present, I think the respective value may be summed up in some such way as this. It would appear from Wagner's* laborious collection of 135 cases of neurectomy, that 18 remained cured after as long a period as three years. I am unable to find any case of nerve-stretching reported as cured after a longer period of watching than eight months.† As the relief after either operation is usually not permanent, the surgeon would be abundantly justified who first submitted his patient to nerve-stretching, and after a relapse gave him another period of relief by the major operation of a thoroughly performed neurectomy.

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* *Arch. f. Chir.*, Bd. xi.

† For a reference to the statistics of Hahn, of Berlin, quoted by Dr. Chandler in his tabulation of cases (*New York Med. Record*), and for Dr. Gray's tables (*Journ. of Neurology and Psychiatry*, May 1882), I am indebted to a paper by Dr. G. R. Fowler (*Annals of Surgery*, vol. iii. No. 4, p. 269), which for its fulness and impartiality is well worthy of reference.

First Division of Fifth Nerve: Neurotomy and Neurectomy.—These two may be considered together.

Neurectomy.—The incision may be made above or below the eyebrow. The latter is preferable, as leaving less scar. The supra-orbital notch being made out* by firm pressure when the patient is under an anæsthetic, the eyebrow is drawn up and the eyelid down, and an incision an inch and a half long is made along the supra-orbital margin, with its centre opposite to the notch. The skin, occipito-frontalis, and palpebral ligament being divided, the cellular tissue is separated, the nerve found in the notch, set free, drawn up with a strabismus hook and a full inch removed.

Neurotomy.—This may be performed subcutaneously or, as above, by an open wound, with antiseptic precautions. Neither are comparable with neurectomy, owing to the rapid union of the nerve. The open method needs no further description. The subcutaneous method may be thus briefly described. The position of the supra-orbital foramen being made sound by firm pressure, a narrow tenotomy knife is entered to the inner side of the nerve and then passed outwards horizontally beneath the skin, till its point has passed beyond the nerve. Its edge is then turned towards the bone, and the nerve divided as the knife is withdrawn. This method is said to be preferable to neurotomy by open wound, as it leaves less scar. Neurectomy however should replace neurotomy.

Second Division of Fifth Nerve: Neurotomy, Neurectomy, and Nerve-Stretching.—Of these, neurectomy will alone be described in detail. In deciding between the only two operations which are of value, the surgeon is referred to the preceding remarks on neurectomy and nerve-stretching.

Neurectomy.—Cases justifying: epileptiform neuralgia resisting all other treatment—*e.g.*, extraction of teeth, the continuous current, &c. Cases in which life is a burden, where, owing to the frequent recurrence from the slightest touch, from a draught of air, or taking food,* the patient is unfit for work, sleepless and emaciating, and, perhaps, becoming a morphia-habitué.

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* "The supra-orbital notch or foramen can be felt about the junction of the inner with the middle third of the supra-orbital margin. From this point a perpendicular line, drawn with a slight inclination outwards, so as to cross the interval between the two bicuspid teeth in both jaws, passes over the infra-orbital and the mental foramina. The direction of these two lower foramina looks towards the angle of the nose."—Mr. Holden, *Landmarks, Medical and Surgical*, p. 6.

Doubtful Cases.—Cases in which the neuralgia is ascending—viz., attacking first the inferior dental, then the superior maxillary, and so on, in spite of operation. If other conditions are favourable, age does not necessarily prohibit the operation.†

Operation.—This, often known as Carnochan's, has the advantage of removing the whole of the second division of the fifth, together with the spheno-palatine ganglion as far back as the foramen rotundum, the nerve forming the guide to the surgeon from the surface backwards.

Carnochan (*Amer. Journ. Med. Sci.*, 1858, p. 136) looked upon the removal of Meckel's ganglion as the key of the operation. Whether his view was right that this body could be likened to a galvanic battery, keeping up a continuous supply of "morbid nervous sensibility," there is no doubt that removal of the nerve *beyond* the ganglion is strongly advisable, as by this step the spheno-palatine branches to the gums are also removed. As pointed out by Dr. Chavasse (*Med. Chir. Trans.* vol. lxvii. p. 151) and Mr. Clutton (*St. Thomas's Hosp. Repts.*, vol. xv. p. 213) removal of the nerve *beyond* Meckel's ganglion ensures the disconnection of the posterior dental nerve‡ from the brain, which is probably the explanation of the success which follows the operation.

An anæsthetic being given, and the parts shaved§ and cleansed, a ⊤-incision is made with the horizontal portion reaching from canthus to canthus just below the orbit, and the vertical one running down close to the angle of the mouth. The flaps thus marked out being reflected and all hæmorrhage stopped, the infra-orbital nerve is defined, cut as long as possible, and a piece of silk tied round it to make it serve as a guide.

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* In a patient of Dr. Fowler's (*Annals of Surgery*, vol. iii. No. 4, p. 300) "every attempt to receive food upon that side of the mouth was followed by exacerbations of pain of the most frightful character. It was only by lying upon the opposite side, and having a funnel passed back to the pharynx, so as to guide the stream away from the diseased side, that he was enabled to take food at all, and that of a liquid character."

† Dr. Maclean, of Detroit, in a discussion on "A Case of Excision of the Inferior Dental Nerve, by Dr. Mears" (*Trans. Amer. Surg. Assoc.*, vol. ii. p. 485), mentioned two cases of men, aged seventy-two and sixty-nine, in the first of whom he excised the infra-orbital and inferior dental; and in the second, the supra- and infra-orbital nerves successfully, the good result having lasted six years in the first case.

‡ In both of Dr. Chavasse's cases the commencement of the pain was invariably referred to the periphery of the posterior dental branches, and it appeared very doubtful if stretching would have had any effect on slender branches at some distance from the extension point. Both of Dr. Chavasse's cases remained practically well two years and a year and a half after the operation.

§ In one of Mr. Clutton's cases this could not have been borne before. Recurrence, slight and relieved by quinine, ensued in both of Mr. Clutton's cases within the year.

A ½-inch trephine is then applied just below, and including, the infra-orbital foramen, so as to remove the anterior wall of the antrum; next, the same sized or a ¼-inch trephine is applied to the posterior wall of this cavity so as to expose the spheno-maxillary fossa. Free and troublesome hæmorrhage must be expected, partly from the vascular facial bone,* partly from the mucous membrane of the antrum, and in the fossa itself, where the bleeding is always copious, from the terminal branches of the internal maxillary. Pressure with small sponges in holders may be relied upon. The next step is to open up the infra-orbital canal with a small chisel, strong scissors, or fine cutting pliers, being used to enlarge the wound.

During the operation, if daylight fail, a laryngeal mirror and artificial, or electric, light, will greatly help the surgeon.

The nerve being now brought into the posterior trephine-aperture, it is traced into the spheno-maxillary fossa, which it enters through the foramen rotundum. Being kept on the stretch by means of the piece of silk, it is severed with long, delicate, curved scissors as far back and as near the foramen as possible. If it is still held by filaments passing downwards (spheno-palatine branches), these should be also divided with scissors. Mr. Clutton considers that the total length of nerve removed from the infra-orbital foramen to the foramen rotundum should be at least 1¾ inch, without including any of its branches. Iodoform should be dusted in at once, and the wound plugged temporarily with carbolized sponges sprinkled with iodoform. When all hæmorrhage has stopped these are removed, and the spheno-maxillary fossa and antrum are lightly plugged with aseptic gauze, or boric lint and iodoform. The flaps are partially adjusted with a few points of suture, leaving room for drainage and the removal of the plugs,† iodoform dusted on, and boracic acid lint wrung out of the same lotion iced, applied constantly and renewed frequently for the first few days.

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* The superficial hæmorrhage will be all the freer in proportion as the part has been recently submitted to blistering, liniments, &c.

† To be removed in twenty-four or forty-eight hours according to the amount of hæmorrhage met with during the operation.

Difficulties which may be met with During the Operation.—1. Hæmorrhage. 2. The nerve breaking, or being divided prematurely. 3. A deep wound, difficult to illuminate, especially if the antrum is deep between the two trephine wounds.

After any of these operations on the fifth nerve the patient should be strictly cautioned to avoid exposure to any of the causes of a return of his enemy. The chief are given below (p. 259).

Operations on the Third Division of the Fifth Nerve.

Neurectomy.—American surgeons aided, perhaps, by the perfection of their mechanical dentistry, have, here also, led the way. The following case gives well most of the points of the operation:—

Dr. Mears[*] removed three inches of the inferior dental nerve, including all that part of it contained in the canal and part of it beyond the mental foramen. The outer surface of the jaw was exposed by reflecting a flap raised by an incision which reached from the middle of the posterior border of the ramus along the horizontal ramus to a point beyond the position of the mental foramen. A ½-inch trephine was applied over the position of the inferior dental foramen, and a disc of the outer table removed. The mental nerve was dissected to the distance of ½ inch beyond its point of exit from the foramen and divided. A dental burr attached to the surgical engine was now used to enlarge the mental foramen and release the nerve. By pulling upon the nerve at the point where it was exposed by the trephine, it was drawn entire from the canal. Before dividing it posteriorly it was drawn down so that the division might be made as high up as possible. The artery, which was torn, was twisted, no hæmorrhage following. The nerve, while in the canal, was found to be swollen and reddened, and the artery seemed compressed and flattened. The wound healed in six days. The patient, save for one or two spasms, remained free from pain for nine months, up to date.

Microscopic examination of the nerve removed showed evidence of a parenchymatous neuritis—viz., degeneration of the nerve fibres, and thickening of the connective tissues.

Nerve-Stretching.—Mr. Pitts[†] gives two cases of stretching of the inferior dental nerve for neuralgia. For more than a year after the operation these cases were free from the slightest return of pain, then relapses took place, but mildly, and the condition of the patients still remained much improved. The nerve was found by a vertical incision within the mouth, along the inner[‡] border of the ascending ramus. The soft parts being separated from the bone with an elevator, and the position of entrance of the nerve being recognised with the finger, the nerve was stretched with a blunt hook, this being passed close to the bone. While it was thus easy to take up the nerve it was difficult not to include the artery as well, and this in one case caused free hæmorrhage, which was arrested by clamp-forceps left on for twenty-four hours. Both patients suffered from swelling of the throat and neck as might be expected from the necessary bruising of soft parts, and the impossibility of satisfactory drainage. Several months elapsed before complete mobility of the jaw was regained. The amount of pull required was not great, and it is advised to stretch the nerve by a "number of small efforts rather than by one jerk."

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[*] *Trans. Amer. Surg. Assoc.*, vol. ii. p. 469.

[†] *St. Thomas's Hosp. Reports*, vol. xv. p. 207.

[‡] Anterior?

Intra-buccal Division.—The following case* is of interest as showing with what facility the complication of hæmorrhage noticed in the last operation may occur.

The patient being etherised, and the mouth held open by a gag, an incision was made, extending from the upper to the lower jaw, along the inner edge of the latter. The spine of Spix was exposed, and the nerve seized with a strong slender forceps at the point at which it enters the dental canal, and divided with scissors above and below the forceps. The small mass removed, however, did not plainly show nerve tissue, whereupon a blunt hook with a short curve was introduced two or three times, until finally, when passed well back and drawn forward, it seized a cord which was supposed to be the nerve. This was divided with scissors, when quite a severe hæmorrhage took place, which could only be controlled by rapidly packing the wound with iodoform gauze. The hæmorrhage recurred the same evening, several ounces more being lost, but it was checked by additional compression, the jaws being firmly bound together so as to force the compress against the wound. The gauze was removed from the wound piecemeal, the last being taken away by the tenth day.

STRETCHING THE FACIAL NERVE.†

As will be seen from the remarks made below (p. 259), it is extremely doubtful if anything more than temporary relief, of a variable duration can be promised by it.

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* Dr. R. F. Weir, of New York (*Annals of Surgery*, June 3, 1887, p. 504). Dr. Weir is inclined to think that this hæmorrhage arose from the internal maxillary.

† The operation given below, that of Baum, is not, accurately speaking, one quite on the face. It may, however, be conveniently considered here.

Operation.—The following account is taken from Mr. Godlee's paper (*Clin. Soc. Trans.*, vol. xiv. p. 45), the method is that of Baum.* An incision begun behind the ear, about opposite to the meatus, was carried downwards and forwards to a point immediately below the lobule, and then prolonged almost perpendicularly, but slanting a little forwards, nearly to the angle of the jaw. A small transverse incision was also made below the pinna. After exposing the edge of the sterno-mastoid and parotid, these structures were separated deeply and pulled respectively backwards and forwards. As soon as the edge of the digastric appeared, the knife was discarded, and the structures immediately above and parallel with the upper border of the muscle were one after the other pulled up with a blunt hook or forceps and cleaned with a steel director. When the nerve was reached and raised on the hook, the twitching at first increased, a somewhat firmer pull averted it for a time, but it began again on relaxing the tension; a still firmer pull not only stopped the twitching, but caused the right side of the face to pass into a state of complete paralysis. One or two further pulls were given, and the wound closed.† The operation was antiseptic throughout. Healing was complete about the ninth day.‡

The performance of this operation is easy in thin patients; in stout and muscular ones it would be decidedly difficult. In different experiments on the dead subject the amount of tension which the nerve would bear differed very much; in some cases it resisted for an appreciable time the strongest possible pull, in others it snapped across with the greatest readiness.

The line for the nerve is exactly parallel with the upper border of the digastric, and it will be found about half-way down that part of the mastoid process which is exposed in the wound—viz., the free anterior border. The great auricular nerve will be in part divided, but as long as the operator keeps in the same plane as the digastric he can scarcely wound any vessel of importance. The deep parts of the wound are in close proximity to the internal jugular vein. The only vessels which should be met with are the posterior auricular vein superficially and its artery more deeply, but a good deal of hæmorrhage may arise from glandular branches, and Mr. Godlee's advice to keep the wound in a good light, well opened out with retractors, and carefully sponged dry, should be remembered.

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* The other method is that of Hueter—by an incision 2 inches long in front of the ear, its centre being opposite to the upper part of the lobule. Dr. Keen (*Annals of Surgery*, July 1886, p. 13) gives the following reasons for preferring that of Baum:—(1) The scar is hidden behind the ear, a point of much importance in women, in whom this affection is not uncommon; (2) it is less bloody; (3) it inflicts less damage on the parotid; (4) it reaches the nerve directly at its emergence from the stylo-mastoid foramen, before it has given off any branches except, perhaps, the posterior auricular. Thus there is no risk, as in Hueter's method, of the branches to the occipito-frontalis and orbicularis escaping. The above advantages outweigh the greater ease of Hueter's operation.

† Adequate drainage by a tube, or gut and horsehair will, of course, be provided.

‡ The surgeon must be prepared for what took place in Mr. Godlee's case—viz., some troublesome conjunctivitis from the gaping of the lids, which was relieved by mildly astringent collyria, and holding up the lower lid with plaister.

Points which Deserve Attention.—(1) Finding the nerve. To avoid needless injury and to shorten the operation, Dr. Keen* found a weak faradic current very useful. A wet sponge was held on the cheek, and a fine wire at the other end was applied to various points in the wound till the nerve was found.

(2) Mode of stretching the nerve. Dr. Keen advises stretching from the periphery towards the centre. The amount of force to be used he estimates at four to five pounds, and that this can best be achieved empirically, by attempting to lift the head (six to seven pounds), and abandoning the attempt the moment any fibres give way. In other words, the stretchings should be as severe as the integrity of the nerve will allow.†

(3) Results of the operation. It appears that while many cases have been, temporarily, very much relieved, as a certain rule, when the nerve recovers itself, the spasms return. Dr. Keen in the table at the end of his paper gives two cases in which the cure lasted much longer, if, indeed, it may not be called permanent—viz., Southam's,‡ in which there was absolute relief for five years, and one under the care of Jesas,§ in which the cure had lasted two years and eight months. Dr. Keen's concluding words are as follows:—"It would seem, therefore, that, whether viewed from the point of palliation or of cure, the operation is, with our present knowledge, to be looked upon favourably. Further observations may show its inutility, but when we consider the

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* *Loc. supra cit.*, p. 13. In the moist condition of the wound a strong current will produce muscular spasm at once, but a very weak current will only do so when the nerve is touched.

† Two cases are quoted—those of Eulenberg and Schüssler—in the first of which the nerve was "physically disorganized" by the stretching, while in the second the nerve lay in a small loop in the cavity of the wound; yet in each the paralysis gradually disappeared and the spasms partially returned.

‡ *Lancet*, August 27, 1881; *Ibid.*, April 10, 1886.

§ *Wien. Med. Woch.*, No. 2, 1884, and No. 27, 1887. It is an interesting fact that no paralysis followed in this case.

utter hopelessness of improvement, much less recovery, from any other means, relief by this operation, even if temporary, is had at a very trivial cost, and would be welcomed by any sufferer, while permanent cure is not impossible."

Mr. Godlee in a second paper,* in which he published the result of his first case—after remaining for nine months practically well, the convulsions suddenly returned after a severe nervous shock, and gradually increased until they regained all their former intensity—sums up somewhat less favourably: "In discussing the question of recommending the operation to a patient, we must not forget that the risk, with due care, is almost nil; that a certain immunity from the trouble may be safely promised for a time, and that this period may be very considerably prolonged, and, while Southam's remarkable case remains completely well, there is always the hope that the relief may be permanent. Were it not for this, however, I am afraid that the general verdict would be that the time has come when this small chapter of surgical therapeutics . . . . must be closed."

It is, of course, to be understood that no patient would be advised to submit to the operation without a thorough trial of other remedies, short of nerve-stretching.

And, after submitting to stretching of the nerve, patients should be most careful to avoid any exciting and predisposing causes of a return of their trouble—viz., exposure to cold chills, sudden bright lights, nervous disorder, mental worry, and living low.

RESTORATION OF STENO'S DUCT.

Where, after burns, stabs, ulcerations, sloughing, operations for removal of growths, a most annoying salivary fistula persists, the patient suffering from disagreeable, hot dryness of the mouth, and from constant irritation and inflammation of the soft parts from the dribbling of saliva, where previous measures—*e.g.*, collodion and heated wire, paring the edges—have failed, the surgeon may adopt one of the following measures:—

(i.) The following will often succeed in a recent case.

The opening into the mouth is first found, or one in its position made, by passing a fine silver probe from the fistula into the mouth.* As soon as the oral opening is found or established, the probe is passed from the mouth along the duct, beyond the fistula, up to the gland itself. The other end of the probe is then brought out of the angle of the mouth, curved, and secured by strapping on the cheek. while the fistula is kept as dry as possible, and covered with collodion, in the hope that it will close,† now that the oral opening is re-established.

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* Both Mr. Godlee's second paper (*Clin. Soc. Trans.*, vol. xvi. p. 220) and Dr. Keen's (*loc. supra cit.*) contain tables, the former giving thirteen, the latter twenty-one cases. Mr. Godlee's case was unwilling to purchase relief from her complaint by submitting to permanent paralysis of the affected side of her face, owing to a dislike of the very obvious nature of the deformity.

Mr. H. Morris (*Clin. Soc. Trans.*, vol. xiii. p. 144) has recorded a case which he successfully treated on the same lines, but with a fine catgut bougie, which is much more easily worn than a probe. He also suggests that it would be well if, during any operation on the face for removal of a new growth, it be found necessary to divide the duct, a bougie should be passed at once, and the patency of the duct secured.

(ii.) In cases of longer standing, where the duct is more obliterated, especially at its narrow oral end, and the restoration is not so easy, some such operation as Dessault's must be performed. A fine trocar and cannula are pushed through the cheek from the fistula forwards and inwards into the mouth, following, as far as possible, the course of the duct. The trocar being withdrawn, a small silk seton is passed along the cannula; this is then taken out and the two ends of the seton, the one projecting from the mouth and the other from the fistula, are tied together; at about the end of three weeks (according to the amount of inflammation) the seton is withdrawn, and the sinus established by it is kept open by probe or bougie, as already described.

When the patency of the new duct is thoroughly established,‡ the external aperture may be closed by collodion painting, the cautery, or paring the edges, according to its size.

OPERATIVE TREATMENT OF LUPUS.§

We owe to German surgeons our knowledge that, from the infecting power of lupus growth, it is impossible, when once it is established, to cure it by constitutional treatment. A further step has been the gradual replacing of local treatment with caustics, or the cautery, by the erasion method of Volkmann of Halle.*

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* Close to the projection of the mucous membrane, which usually denotes the position of the orifice of the duct, opposite to the second upper molar tooth.

† If this fails, a plastic operation of paring the edges and uniting them with numerous fishing-gut sutures will probably be required.

‡ Mr. Erichsen (*Surg.*, vol. ii. p. 557) suggests the passage of a piece of laminaria tent, if the sinus shows much tendency to close.

§ The above account, while introduced here from the greater frequency of lupus on the face, is, of course, applicable to the disease elsewhere.

Lupus is so frequently met with in this country, the deformities which it produces are so odious, and it is so readily arrested by local treatment vigorously applied and energetically repeated, that a few practical remarks will be made on the two chief methods of using it—viz., erasion and scarification.

Mr. J. Hutchinson thus compares the three methods of local treatment (*Brit. Med. Journ.*, May 1, 1880): "All are very good, but I unhesitatingly prefer the last. If caustics are used, they must be used very freely. I have repeatedly seen a patch wholly cured by a single dressing with chloride of zinc or acid nitrate of mercury. As a rule, these remedies are used too timidly or without sufficient painstaking. They give more pain than the actual cautery, but their sores granulate better and heal more quickly. The actual cautery is comparatively painless, can be easily limited, and at the same time made to act deeply. It is very efficient, but its burns are somewhat slow to heal. The erasion treatment appears to give less pain, to be very efficient, and to leave a sore which heals rapidly and soundly."

Before speaking in detail of these methods it will be well to say a few words about the chief forms of lupus, and to which of these erasion or scarification is best suited.

I think that for the purpose of treatment the surgeon should keep two great types before his mind. In one of these the lupus deposit takes the shape of more or less localized nodules, tubercles, or nests, reddish or yellowish pink, often quasi-gelatinous, and prone to attack the cheeks near the junction of the alæ and the upper lip. In the other the lupus deposit is much more diffused, usually, too, more superficial and less inclined to form nodules or nests. This type is met with both on cheeks and nose, but is best seen on the latter. It is, in my experience, much the most frequently met with form in the surgical wards of a London hospital, and is the one most frequently responsible for marring the above important feature in young patients, usually girls. This is the lupus seborrhagicus of Prof. Volkmann,† the seborrhœa being of secondary importance, the essential point being the fine-cell lupus infiltration of the cutis, which develops most freely in the neighbourhood of the sebaceous glands, in which the cheeks and nose are so rich, and gives rise to an increased secretion on their part.

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* Germ. Clin. Lect., *Syd. Soc. Transl.*, p. 97.

† Prof. Volkmann (*loc. supra cit.*, p. 105) gives the following life-like description of this form :—Irregular, reddish-looking patches met with on the cheeks and nose, often covered with "dirty-looking, thin crusts, which are distinctly fatty to the touch. They consist, in fact, of nothing further than an excessive secretion from the sebaceous glands of the skin mixed with epidermis cells. When we

Erasion.—This is most strongly indicated in both the above forms of lupus, whether localized or diffused. The best instruments are sharp spoons, with oval ends of varying size, or hoes; whatever instrument is used should be of steel, the silver scoops supplied in dressing-cases being inefficient. Where the lupus deposit is of any size it should be deliberately and thoroughly scraped out, the instrument being carried most painstakingly both over the surface and around the edges. Where the deposits are more minute they must be as carefully picked out. The surgeon need not fear removing too much, as long as he keeps to parts which yield to a scoop which will never remove sound, and only with difficulty, partly sound, tissues.*

Scarification.—This is only useful in the more diffuse forms, and is to be employed in two ways. (*a*) Linear. With a fine and very sharp scalpel the surgeon makes scores of fine delicate cuts, parallel with each other, through the diffuse lupoid deposit crossing these again with similar delicate incisions at a right angle the first.† All these must be made quickly and with a light hand, and care must be taken, as far as possible, not to let them run into each other. The bleeding is extremely free, but is readily arrested by carefully maintained pressure.

(*b*) Punctiform. Here hundreds maybe of punctures are made in the diffused lupoid deposit, a delicate hand being again required, and a fine sharp scalpel point or a large needle being used. In this case, also, every pains must be taken to place the punctures equidistantly. After arresting the bleeding the sur-

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have succeeded, with great difficulty, in scraping off this fatty layer with the knife, the underlying skin appears red, sore, and as if studded with fine warts. But if you examine these warty points more closely with a glass, you see that it is by no means a question of papillary elevations, but of a large number of fine holes, which, being closely adjacent to each other, produce the warty appearance. These holes are the enlarged openings of the sebaceous ducts, and you can also see on peeling off single fatty crusts how a fine prolongation of the latter becomes detached from each small opening."

* As pointed out by Prof. Volkmann (*loc. supra cit.*, p. 114) in cases of lupoid ulcerations of longer standing, an almost fibroid tissue becomes exposed after the diseased parts have been scraped off, a condition which is to be regarded as the expression of reaction in the neighbourhood.

† No scarring need be feared from either form of scarification. After three weeks have elapsed the above incisions, however numerous, if done with proper delicacy, can only be detected by looking for them very closely. In three months it usually requires a lens to find them.

geon looks carefully over the patch; if at any spots his incisions or punctures are crowded together with intervening places but little touched, he again goes over his ground carefully.

If, after the completion of these operations, the tissues appear tallowy or whitish, there need be no fear of gangrene, the parts being far too well supplied with blood. Prof. Volkmann, after using the above methods, wipes the parts over with a stick of silver nitrate, and applies dry lint. I prefer to use iodoform gauze at first to the bleeding surface, the gauze being washed off with warm water in about forty-eight hours, when iodoform ointment or lead lotion may be made use of.

An anæsthetic should invariably be given.* Repetitions are usually required in severe cases, two or three times, at intervals of three weeks or more, or whenever minute reddish specks appear and grow around the original disease, or when the scar, though not again ulcerating, remains obstinately dark bluish-red.

The object of scarification is, of course, to obliterate the lupoid deposit by the formation of scar tissue.

Where the nose is affected, the inner aspect of the orifices should be examined in case the mucous membrane is invaded.

OPERATIVE TREATMENT OF RODENT ULCER.

Owing to the great frequency of this disease on the face, the following remarks are inserted here:—

Some Points of Practical Importance.

i. **Propriety of Operation.**—In this form of malignant disease, owing to its extremely slow progress, its very long connection with some well-known flat-topped wart, patients sometimes keep on deferring the operation till their age and the extent of the ulcer cause some difficulty in urging or advising an operation.

The following may help in forming a decision:—(1) The extent, depth, and site of the ulcer. A case of moderate severity—say of the size of half a crown—may nearly always be submitted to operation. But the difficulty of deciding will be much greater in cases which involve extensively the nose, orbit, and eye, as well, perhaps, especially if the bones on the delicate inner wall are much involved; in the rarer cases in which orbit, nose, and mouth are thrown into one hideous chasm,* and those cases, also rare, in which the ulceration extends very widely, though superficially, involving forehead, temple, and parotid region.† (2) In all cases of severity the following should be carefully considered —viz., the real age ‡ of the patient—*i.e.*, the age not reckoned by years alone—his habits, how long he probably will live if no operation is performed; whether the disfigurement seriously interferes with the following of an active life; whether there have been any brain symptoms referable to the growth; the condition of the viscera; any liability to erysipelas; finally, each case being considered by itself, certain conditions will justify operations in otherwise doubtful cases, as when a rodent ulcer, having destroyed the sight of one eye, is creeping across the nose and threatening the opposite one.

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* Dr. Balmanno Squire recommends (*Brit. Med. Journ.*, May 1, 1880) the freezing the skin with ether spray. This so entirely alters the feel of parts that I have not used it. Cocaine may perhaps be useful in the lighter cases. For rendering scarification expeditious and precise Dr. Squire has devised a multiple linear scarifier. This instrument (Weiss) is most useful in port-wine stains, though I prefer fine, very keen scalpels, which will suffice both for linear and punctiform scarification.

ii. **The Operation Itself.**—In these days of aseptic surgery, the combined operation by knife and caustics, or cautery, will be preferred to one by caustics alone, on account of its greater precision, and more rapid and more painless healing, from the absence of fetid sloughs, and the diminished liability to erysipelas, &c. The following hints may be found useful in an extensive operation.

(1) To diminish the risks of erysipelas in these patients the

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* As in figs. 2 to 6 at the end of Mr. Moore's work on *Rodent Ulcer.*

† Mr. Moore (*loc. supra cit.*, fig. 9) shows one of these superficial but vast rodent ulcers; and his cases vi. and vii. show the exceeding difficulty, if not impossibility, of completely curing them, even in hands as experienced as his. He thought (p. 58) that the firmness of the skull presented a mechanical obstacle to the complete healing of these large sores. Mr. Hutchinson (*Clin. Surg.*, vol. ii. pl. 65) points out that this extensive form may be very superficial for a long time, may even cicatrize with tolerable soundness, but that, sooner or later, a stage of deep growth and rapid progress is almost certain.

‡ Sir James Paget's words on the risks of operations in old people (*Clin. Lect.*, p. 6) may be quoted here: "They that are fat and bloated, pale with soft textures, flabby, torpid, wheezy, incapable of exercise, looking older than their years, are very bad. They that are fat, florid, and plethoric, firm-skinned, and with good muscular power, clear-headed, and willing to work like younger men, are not indeed good subjects for operations, yet they are scarcely bad. The old people that are thin and dry and tough, clear-voiced and bright-eyed, with good stomachs and strong wills, muscular and active, are not bad; they bear all but the largest operations very well. But very bad are they who, looking somewhat like these, are feeble and soft-skinned, with little pulses, bad appetites, and weak digestive power, so that they cannot, in an emergency, be well nourished." Sir James goes on to speak of their inability to bear loss of blood, the lazy healing of large wounds, the liability of their stomachs to refuse food, their prolonged convalescence, their getting "all but well," and the need of meeting these special dangers with special cares.

parts should be carefully cleansed and kept as aseptic as possible by means of precautions similar to those given at p. 240.

(2) Steps of the operation itself and the application of caustics. —The surgeon first makes a groove-like incision * around the whole, or, in a very extensive case, around part of the growth, and well wide of it, and arrests the bleeding by ligature, leaving on Spencer Wells' forceps, or by sponge-pressure. The next step—that of removing the affected soft parts—is often difficult, owing to their proneness to break away, and thus giving no firm hold to forceps; a sharp spoon is often very useful here, but scraping alone is not to be trusted to. Having scraped away the growth down to tissues apparently healthy, the surgeon scrutinises these most carefully, picking out every atom of yellow-grey granulation-like material, and then again repeating the scraping with careful thoroughness. Where the bones themselves appear eaten into, scraping will not be sufficient, and it will be wiser to go over the worm-eaten surface with a fine gouge or chisel.† In one region especially these must be used with the utmost caution—*i.e.*, where the paper-like bones on the inner wall of the orbit are involved; in this place, if the surgeon is not satisfied with the limited use of the gouge or chisel—which is alone permissible here—he must be content with finally applying Paquelin's thermo-cautery, unless removal of the eye, at the same time, has allowed of the use of zinc-chloride paste. In other places this most valuable caustic may be used fearlessly, as long as precautions are taken to use it in a concentrated form, and to apply it as firmly and as thinly as possible, so that the discharges from the wound shall not allow it to liquefy and run either towards the eye or nose or throat.

(3) Question of removing the eye in cases where the conjunctiva is involved. As a rule, consent should be obtained for this step if needful. Cases clearly requiring it will be those where (a) the eye is already useless, or so distinctly deteriorated that it cannot improve; (β) where the lids have shrunk off away from it, and left it irritable and painful from exposure; (γ) where the disease cannot otherwise be removed or caustics be made use of.

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* A pair of sharp blunt-pointed scissors may be found useful when the lids have to be cut through.

† Mr. Moore (*loc. supra cit.*, p. 51) speaks decisively on this point: "The bone itself must be taken away to a depth exceeding that which has yielded to the disease. Recurrence is otherwise inevitable." Mr. Moore seems to have used cutting bone-pliers for this purpose.

As a rule, if the conjunctiva is much involved, the necessary removal of this will cause sloughing. Occasionally, this only threatens, and then passes away. Three years ago a patient of Drs. T. and J. B. Howell, at Wandsworth, came under my care for extensive rodent ulcer. Both lids of the right eye, the conjunctiva largely, the inner part of the orbit, root and right side of the nose, and upper part of right cheek were involved. Operation had been advised ten years before. After removal of the soft parts involved by the growth, it was found that the lachrymal and ethmoid were much involved, being very vascular and worm-eaten. Repeated applications of the sharp spoon and a small gouge were made use of, and finally Paquelin's thermo-cautery was applied. The inner half of the conjunctiva was involved, and removed freely, the internal rectus being exposed. The cornea became cloudy and discoloured, and though on the third day the pupil was visible and the patient could distinguish between the medical men at his bedside, the cornea ultimately sloughed, and I removed the eyeball a few weeks later.*

iii. **The After-Treatment.**—(1) The chief object here is to keep the wound scrupulously sweet. I prefer for this gently packing the wound with iodoform gauze, or, in cases where erysipelas may be expected, dusting with iodoform, and dressing with boracic-acid lint soaked in a saturated solution of the acid, and changed at regular intervals. Sufficient morphia should be given for the first day or two, and the bowels kept regularly open. If zinc-chloride paste has been used, attention must be paid, as already advised, that it does not melt and run into parts like the eye, nose, or mouth, and for this same purpose the position of the patient's head must be looked to. (2) If it has been found needful to attack vigorously the bones of the skull, or even to apply some of the caustic to diseased dura mater, and if during the first ten days of the disease fits make their appearance, it does not necessarily follow that cerebral inflammation is setting in. According to Mr. Moore the fits may be slight and the unconsciousness of brief duration, or the fits even severe and attended with coma, but, as a rule, they are recovered from. (3) Secondary hæmorrhage. This is rare after the use of zinc-chloride, which forms deep, tenacious, black sloughs, and also seems to me to prevent the risk of pyæmia. But if the cautery only has been used, the amount of fœtor is much greater, and in parts so vascular that secondary hæmorrhage may easily occur, if the wound is foul. (4) Recurrence. The patient must always be most carefully watched, and, in the case of extensive and deep disease, any suspicious granulations that appear must be attacked at once. (5) When after a severe operation a plastic operation cannot be performed, very much may be done by a well-made vulcanite mask.*

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* It would certainly have been wiser to have removed the eye at the first operation, a step which would have facilitated the use of zinc-chloride paste. The patient, however, had so much difficulty in making up his mind to be operated on, that it was thought best to attempt to do without the additional mutilation if possible. There has been no recurrence.

REMOVAL OF PAROTID GROWTHS.

The question of operation arises here under three somewhat different conditions—viz.:

(i.) In the case of the ordinary parotid tumour.

(ii.) In that of a sarcoma of the parotid, which has often started in the growth just mentioned.

(iii.) In carcinoma of the parotid.

(i.) **Removal of an Ordinary Parotid Tumour.**—These well-known growths, containing a mixture usually of fibro-cartilaginous, myxomatous, and imperfect glandular tissue require no especial allusion here, beyond the need of—(1) Exposing them sufficiently, (2) Paying strict attention to the facial nerve, and (3) Removing the capsule itself, after the growth has been shelled out, in any cases of doubt—viz., soft consistency, or rapid growth.†

(ii.) **Operation in Sarcoma of the Parotid.**—This usually begins in one of the growths just mentioned. This and the next group may, as far as operations go, be considered together, it being remembered that there is this difference between them, that carcinomata are here more malignant, as a rule, than sarcomata.‡

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* As is shown in figs. 6 and 7 in Mr. Moore's book, *loc. supra cit.*

† In an article (*Guy's Hosp. Reports*, vol. xxvi.) "On the Enchondromata of the Salivary Glands," I ventured to say, with regard to the removal of these growths, "if the wound be made too small in the first case for fear of a scar, the edges will only be bruised and primary union prevented. It is not uncommon for branches of the facial nerve to be in relation with the capsule of the tumour, and if this has been much handled, or treated by counter-irritation, they may very likely be firmly adherent. In either case injury to the nerve may be best avoided by slitting up the capsule and shelling out the enchondroma first. The capsule should then be examined to see if any nerve branches are adherent to it; after these have been separated, the capsule itself should be removed. This should always be done to prevent any recurrence, as the peripheral part of these enchondromata is often adherent to the capsule itself.

‡ Thus Mr. Butlin (*Oper. Surg. of Mal'g. Dis.*, p. 117) speaks of carcinoma here as a very dangerous and fatal disease, but of sarcoma as appearing, whether in the pure or mixed forms, to be a far more benign disease than sarcoma of most of the other parts of the body.

(iii.) **Operation in Carcinoma of the Parotid.**—The question of the advisability of interfering at all with really malignant growths of the parotid, especially carcinomata, has been much disputed, but as each case must be decided by itself, and as no hard-and-fast line can be laid down here, some useful practical points may be mentioned. On the one hand, attention must be strongly drawn to the fact that reports of operations here are often brief, and that too often they are published as soon as the patient leaves his surgeon, and thus two-thirds of their value are lost; on the other hand, I may perhaps remind my younger readers that a malignant tumour in this region is one in which, above most others, he must not allow a wish to relieve a patient to overcome a decision arrived at after careful examination, for there is scarcely any part of the body in which a malignant growth so quickly obtains a firm hold on the surrounding structures—a fact which has even a more grave bearing on the operation than the importance of these structures themselves.

Practical Points in the Removal of Parotid Tumours.

Characters of the Tumour.—Amongst the most notable of these are—(1) Mobility—viz., how far it can or cannot be lifted up by the fingers from the subjacent parts. (2) Rapidity of growth. (3) Density—thus a great hardness or evident softness will be, alike, unfavourable, the latter from the fact that such soft growths will break down during attempts at removal, and leave parts behind. (4) Pressure symptoms. Of these, dyspnœa, dysphagia, presence of outlying masses in the fauces, and facial paralysis[*] are of evil omen. (5) Condition of the overlying skin.[†]

Points in the Operation Itself.—To begin with, the growth must be sufficiently exposed by adequate incisions. Probably none will be more generally suitable than a ⊢ shaped incision, the longitudinal portion lying over the large vessels, and the transverse one exposing the facial part of the growth.

If the skin is adherent at any spot this should be removed at the same time. The growth being sufficiently exposed, the extirpation of it had best be begun in front and above,[‡] the posterior part being left to the last, as here lie the most important relations, and as these can be most readily dealt with when the growth has been freed elsewhere. During the operation a blunt dissector should be used as much as possible, aided by touches of a blunt-pointed bistoury, and by dragging the growth in different directions. Every vessel, as soon as cut, should be secured with Spencer Wells' forceps, and the free oozing from the vascular skin and other parts arrested by sponge pressure while the surgeon is engaged with some other part of the growth.

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[*] Prof. Billroth, quoted by Mr. Butlin (*loc. supra cit.*, p. 118), considers that facial paralysis from the pressure of a parotid tumour is a sign that this is probably a carcinoma, for the sarcomata and other tumours rarely produce paralysis by pressure, although paralysis frequently follows the operation for their removal.

[†] The more adherent, discoloured—viz., reddish purple—are the integuments, the more unfavourable is the prognosis.

[‡] M. Bérard (*Maladies de la Gland parotide*, p. 240) advises that after the growth has been freed in front, it should be next attacked from below upwards, and not from above downwards, for these reasons—(1) The blood flows away from the

M. Malgaigne* advised that when the surgeon was working posteriorly and deeply he should have the mouth widely opened, as this movement, by removing the condyle from the meatus, enlarged the space in which the instruments were working.

In addition to the free oozing, and the presence of important vessels, other difficulties which may present themselves are the breaking down of a soft growth, thus baffling attempts at complete extirpation, and the strong processes of fibrous tissue which, passing normally from the parotid to some important adjacent structures—viz., the digastric, the internal pterygoid, and the carotid sheath—are now liable to be either increased in density, or softened by extension of the growth.

Two points require especial attention here—viz., the amount of facial paralysis which may be expected,† and the hæmorrhage.

Facial Paralysis.—While in the case of a smaller growth, if the nerve has only been bruised, or, when divided, if the ends have been placed in contiguity, union may take place, and the paralysis gradually disappear,‡ in the case of really malignant growths the question of future deformity must be set aside, and the nerve divided as soon as seen.

Best Modes of Meeting Hæmorrhage.—The chief vessels which will be met with are, the superficial temporal, transverse facial, occipital, posterior auricular, the internal maxillary, and external carotid. The external jugular vein, and large communicating branches between it and the internal jugular are sure to

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wound, and not over the instruments of the surgeon ; (2) the same vessels do not have to be tied more than once ; (3) if any large vessel has to be cut, it is secured early, thus diminishing the amount of hæmorrhage.

* *Operative Surgery* (translated by Dr. Brittan), p. 349.

† If the surgeon, especially in less serious cases, when making any deep incision that is needful, can manage not to go above the level of a line drawn horizontally ¾ inch below the lobule of the ear, he will avoid any serious interference with the trunk of the facial nerve, and thus escape the risk of permanent paralysis.

‡ This gradual improvement is alluded to, with a case in point, in my article, *loc. supra cit.* Mr. Butlin (*loc. supra cit.*, p. 120) suggests a trial of nerve-suture here.

be cut, while the internal jugular vein is almost certain to be seen in the bottom of the wound.

It must be remembered that not only will all the above vessels be liable to be much enlarged, but numerous other unnamed anastomoses will be present.

The common carotid has several times been tied prior to this operation. With all due deference to those who have adopted this practice, I would advise that this step should be dispensed with if possible, and for these reasons—(1) It introduces certain grave additional risks of its own. (2) It takes up time which will be wanted in the operation itself, especially if the projection downwards of the growth into the neck overlaps and conceals the position of the vessel. (3) It is by no means a certain preventive of hæmorrhage here, any more than ligature of both linguals can always be relied on to prevent hæmorrhage during extirpation of the tongue. (4) This step, recommended by many of the older surgeons, is not so needed now in these days of anæsthetics, with an almost unlimited variety of forceps and ligatures at hand. (5) Finally, it would appear better, because simpler and equally efficient, to meet the hæmorrhage from the large vessels before they are cut, by taking them up with two pairs of Spencer Wells' forceps, dividing the vessel between these, and tying or twisting both ends.

In dealing with any large veins the risk of the entrance of air should be prevented by making finger-pressure on the cardiac side, or by securing them with double ligatures before they are cut.

If ligature of the common carotid is to be made use of here, it should, in my opinion, be reserved for those cases in which the surgeon decides to attack a very soft and vascular growth, as here the vessels may be very numerous and difficult to isolate, and ligatures may not hold. In such a case, instead of tying the common carotid and thus exposing the patient to the risks of brain mischief, it would be better to pass a loop of chromic catgut ligature around the vessel, loosely tied, and to ask an assistant to keep up tension on this whenever bleeding takes place. This method seems to have been first used by M. Roux, and of late by Mr. Rivington[*] and Mr. Treves[†] ("Ligature of Common Carotid").

If the wound has become foul—and sometimes in these operations near the mouth and nose it is impossible to keep the bandages from shifting—the surgeon must always be prepared for the accident of secondary hæmorrhage. And on account of the same risk the actual cautery should never be used at the bottom of a very deep wound near to any suspicious tissues, if it can be possibly avoided. If some caustic is required, zinc-chloride paste, used with the precautions given at p. 265, would, I think, be preferable from the absence of fœtor with which it works, and the dry black scabs it forms.

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[*] *Med.-Chir. Trans.*, vol. lxix. p. 72.

[†] *Lancet*, January 21, 1888.

OPERATIVE TREATMENT OF NÆVI.*

The first question which usually arises is whether these growths should be operated on at all, or whether they may be safely left to themselves. While there is a distinct tendency for nævi, after a term of life, to undergo fibro-cystic change, I doubt if this tendency to spontaneous disappearance is as high as Dr. J. Duncan (*Edin. Med. Journ.*, 1886, vol. i. p. 702) puts it—viz., that "certainly more than half are thus naturally cured." In private practice, where a nævus is not extending, where it is in neither a dangerous nor a conspicuous place, it is justifiable to watch the nævus, remembering that the times of teething and of puberty may bring about atrophy or increase, and that the former, while often spontaneous, is most likely to follow one of the exanthemata. But when a nævus occupies a dangerous site, one where irritation of any kind is likely to bring about hæmorrhage, *e.g.*, scalp, lips, tongue, palate, genitals, rectum, fingers, or toes, or where the site is a conspicuous one, no time should be lost in effecting a cure.

While admitting that there is a distinct tendency for a nævus to degenerate ultimately, I should advise operative treatment in nearly all cases, for the following reasons:—(1) During its growing and stationary stage the nævus is always a source of anxiety and often of disfigurement. (2) In hospital practice there is the greatest difficulty in persuading the mother to put up with any deformity that is remediable in her child. (3) In early life nævi are usually small, and easily and safely cured. (4) The spontaneous cure of a large nævus may leave, by much puckering of the skin, more deformity than that of an operation. Before describing the different operative measures I would remind my younger readers (α) that there is no method suited to all cases; (β) that it is very easy, by using heroic means and doing too much, to cause needless scarring; (γ) that during the cure of large nævi in early life the patients are liable to pyrexial attacks and grave malaise.

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* I have spoken of their treatment now for convenience' sake, and because of their great importance on the face.

Different Methods.

1. *Collodion.*—This may be tried in tiny cutaneous nævi. These can, however, be better treated otherwise. In all other nævi it is a harmless placebo. (2) *Vaccination.*—This is not to be recommended. From a very large number of cases which I have seen where this has been used, I am of opinion that it very rarely cures the nævus, while the vaccination is not reliable. (3) *Subcutaneous Discission.*—This is an excellent means of obliterating a nævus without scarring, introduced by Dr. Marshall Hall. A cataract-needle is passed from a point about a line from the margin of the nævus to the opposite extreme edge of the growth. The needle is then withdrawn almost to its point of entrance, and pushed again through the nævus at about $\frac{1}{10}$ inch from the line of the first puncture, and so on till the lines of puncture take a fanlike shape. Should the needle penetrate the skin, pressure must be applied. This method is best adapted to subcutaneous or mixed nævi of moderate size. After a few weeks repetition may be needful. (4) *Nitric Acid.*—This is useful in cutaneous nævi. The parts around should be smeared with vaseline, but neither the match nor glass rod should carry enough to run any risk of damaging the adjacent skin. Careless use of the acid may produce most odious scars. (5) *Sodium Ethylate.*—This is useful in cutaneous or mainly cutaneous nævi. It is efficient, not very painful, though accompanied with a good deal of tingling, and its scars, if it be carefully used, are little conspicuous. If some aseptic wool is secured with collodion over the eschar, this separates without suppuration. Dr. J. Duncan (*Edin. Med. Journ.*, 1886, vol. i. p. 707) thinks this escharotic most suited for those cutaneous nævi where the centre has become obliterated and the margin remains. (8) *Electrolysis.*—This method has the advantage of leaving a minimum of scar or pucker behind it. The disadvantages are that it requires several sittings—on an average, three—and, as an interval of six weeks should elapse between each, the treatment is spread over a considerable time. For this reason the method is not suited to hospital patients, who are ill content if the blemish is not speedily removed. Electrolysis is best suited to those nævi which are subcutaneous and easily got at—though for the majority of these I prefer excision—and for those nævi which are unsuited to excision, and where the cautery will leave a conspicuous scar upon the eyelids and nose. Dr. Newman (*Brit. Med. Journ.*, 1882, vol. ii. p. 248) writes: "The cases for which

electrolysis is eminently suited are superficial, dark-coloured, sluggish, vascular growths, which do not possess special or abundant blood-supply. They waste away after one or two sittings as a matter of moral certainty. Next in order are those nævi which, agreeing with the above in their actual vascularity, yet have much more of surface covering, and which do not, therefore, so readily declare the conditions of their blood-supply. A majority of these cases will probably be found to be quite amenable to the electric current. On the other hand, the cases in which electrolysis will not, at least as a rule, succeed, are those which are intensely vascular, which are rapidly growing, and which it is fair to conclude have more or less direct communication with blood-vessels." Dr. J. Duncan (*loc. supra cit.*) thus describes the method which he has done so much to improve:—"Practically, in electrolyzing a nævus we introduce subcutaneously so much caustic potash and nitric acid made out of the tissues on the spot. We introduce them in such infinitely minute division, and we so destroy tissue in producing them, that their action is purely local, and they cannot be carried into the circulation, while the small quantity produced is yet extremely potent, because it is nascent. By doing this subcutaneously we avoid the evils of putrefaction and we conserve the skin. . . . . After trying many batteries of constant current, I have reverted to the Bunsen or Smee, with four to six cells of large size. In the Infirmary, where it can be prepared by others, I use the Bunsen of four cells, as giving the largest amount of chemical work with the least tension. But in private, Smee's battery with plates about 4 inches by 6, and having six cells, is most convenient. It is less dirty, has only one fluid, and is equally effective." Before operating, the poles should be tested in saline water, and only used if the evolution of gas is copious and continuous.

The needles recommended are those introduced by Prof. Fraser and Dr. Duncan. They should be insulated with vulcanite. The length of the exposed point should vary from ⅛ to ¾ inch, according to the size of the nævus. Steel is the best material; but the positive pole, if of steel, requires re-sharpening after each operation, because it is acted on electrolytically. Both poles should be introduced, as giving most work in the least time. In small nævi they are best placed parallel, and equidistant from each other and from the sides of the tumour. In large nævi Dr. Duncan moves them, especially the negative, from place to place, and introduces them through new punctures. If left stationary, the action rapidly diminishes after ten or fifteen minutes, on account of the slough with which they surround themselves. It is necessary to watch very closely the growing induration round each needle. It increases slightly even after the needles are withdrawn, and the action must be stopped before the skin is involved. If the needles be very slowly withdrawn while the battery is still working, so as to cauterize slightly their track, not a single drop of blood will flow, otherwise pressure should be applied for a few minutes. The nævi should then be covered with aseptic wool and collodion. In large nævi too much must not be done at one sitting or in one place. The slough has to be absorbed, and it is better to establish several small sloughs at different parts than a great mass at one. An anæsthetic is required even in adults. (9) *Excision.*—I use this method very largely for nearly all subcutaneous and mixed nævi save those on the face, and for many large cutaneous ones where the scar will be hidden. There is a very great probability of primary union; it is a rapid method, leaving no slough to separate as does the ligature, and needing no repetition as in electrolysis. Two points require notice; one is the risk of hæmorrhage. This is met by working rapidly, by judiciously applied finger-pressure, by keeping wide of the nævus, and, where the bleeding will be severe, by using the method of Mr. Davies-Colley. My colleague passes two needles, at right angles to each other, beneath the base of the nævus, and twists around and below them a fine drainage-tube; below all, two or three silver sutures are passed deeply. After the nævus is removed, the needles and drainage-tube are withdrawn, and, before bleeding can occur, the sutures are quickly twisted up. The other point is the advisability of leaving any nævoid skin in the excision of a large mixed nævus. While the greater part of the diseased skin should always be removed, narrow strips left on either side will, usually, slowly take on a natural colour. In excision irrigation with hot perchloride, 1 in 2000, should be made use of, drainage with horsehair employed, and the wound carefully united with sutures of fishing-gut and horsehair duly soaked in carbolic acid, 1 in 20. (10) *Cautery.*—Paquelin's cautery is usually employed, the large blade at a red heat being carefully wiped over a cutaneous nævus, and the fine point used for the subcutaneous ones. This is made to penetrate the skin at one spot, and then made to traverse the nævus in several directions from the one puncture. It is most effectual, but the more I see of it the less I like it, owing to the large scars it leaves. Thus the black sinus or sinuses left after the operation with a red margin of scorched skin suppurate and heal tediously, and with much disfigurement in exposed places. If this method is to be used, it is far wiser to use a cautery battery and the fine platinum points which any electrician can supply. If, in hospital practice, the surgeon arranges for his nævi cases to attend on one day, there should be no difficulty about the battery being ready. The amount of scarring left is far less than that by the Paquelin's cautery. No anæsthetic is required with either in infants, the pain being momentary. A very simple form of cautery for those stellate patches which appear on girls' faces long after infancy is supplied by a needle heated or dipped in nitric acid. An anæsthetic should be given. Another excellent means for healing minute nævi is to make a puncture with a tenotome, and apply for a few seconds a finely pointed stick of silver nitrate. (11) *Ligature.*—I have long entirely abandoned this, owing to its painfulness, its production of a slough and large scar, and the risk there is that parts of the strangled mass are very apt to escape obliteration. (12) *Injection.*—This, as usually performed with an iron preparation, is extremely risky, and should never be made use of unless the nævus is securely surrounded, as with a ring-forceps. Several cases fatal from thrombosis and embolism have been recorded (*Lancet*, 1867, vol. ii. p. 191). I remember witnessing one in my student days. The late Mr. W. M. Coates, a surgeon of wide experience, used iodine injection with much success (*Brit. Med. Journ.*, 1883, vol. ii. p. 319). About ½ drachm of the undiluted tincture is thrown in slowly by means of a Wood's syringe with a very fine needle. By moving the point, the tincture is thrown into every part. On withdrawing the needle, pressure on the puncture is required for a few moments. The nævus hardens at once and slowly disappears. No scarring results. Mr. Coates considered the iodine quite free from any risks of thrombosis.

CHAPTER V.

EXCISION OF THE EYEBALL.

EXCISION OF EYEBALL.*

Indications.

i. New growths—*e.g.*, glioma of the retina, melanotic sarcoma of the uveal tract.

ii. In the following cases of injury and its results :—

(*a*) The eyeball ruptured and collapsed after a blow.

(*b*) A large jagged foreign body in the eye—*e.g.*, a bit of metal, not removable without inevitable disorganization.

(*c*) If (Nettleship's *Diseases of the Eye*, p. 142) the wound, lying wholly or partly in the dangerous region,† be so large and so complicated with injury to deeper parts that no hope of useful sight remains.

(*d*) If, though the wound be small, it lie in the dangerous region, and have already set up irido-cyclitis.

(*e*) Where a small foreign body—*e.g.*, a shot glancing in cover shooting—not removable by an electro-magnet, gradually sets up inflammation and shrinking of the eye.

(*f*) When there is a wound in the dangerous region complicated with traumatic cataract.

(*g*) When traumatic cataract has been set up by a wound which is wholly corneal, and therefore out of the dangerous area, and yet severe iritis and pan-ophthalmitis come on in spite of treatment.

iii. As part of an operation for rodent ulcer which has extensively involved the conjunctiva (p. 265).

iv. As part of an operation for removal of orbital tumours—

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* As the general surgeon may be called upon to perform this operation at any time, and as it should always be practised on the dead body, it is included here.

† A zone nearly ¼ inch wide surrounding the cornea.

e.g., a glioma or sarcoma which has ruptured the sclerotic, rodent ulcer, scirrhous, sarcomatous, bony growths, &c.*

Operation.—The chief object is to remove the globe alone, whenever this is possible, leaving the muscles to coalesce and form a stump on which the artificial eye may be supported and be movable. As much conjunctiva as possible should be left.

The surgeon, standing in front, having inserted a spring speculum between the lids, snips with blunt-pointed scissors through the ocular conjunctiva close to the cornea and all round it, using toothed forceps to lift the conjunctiva, and leaving enough at one side to hold on by the forceps during the next step. This is to open freely Tenon's capsule, and catching up each rectus tendon (beginning usually with the external rectus) with a strabismus hook to divide them close to the sclerotic, leaving the cut end of the external rectus long, in order to draw the eyeball forcibly inwards. The superior and inferior rectus are then cut, and the speculum pressed back into the cavity of the orbit so as to make the eyeball start forwards. The scissors, blunt-pointed and slightly curved, are now passed back to feel for the optic nerve, which may be known by its toughness and thickness, and which is now severed with one clean cut. The eyeball being drawn forwards with a finger, the oblique muscles and any remaining soft parts are to be cut close to the globe. Sponge-pressure is then to be applied firmly for a few minutes, and for the first ten hours aseptic sponges and a bandage should be worn to prevent temporary but troublesome hæmorrhage.

In the case of a new growth—*e.g.*, glioma—the optic nerve must be divided as far back as possible. The scissors, slightly curved and long enough to reach to the back of the orbit, are introduced on the inner side, and the nerve either cut as far back as is possible before the globe is removed, or, after this is done, the nerve is dissected out and a fresh slice taken.

Where there is any suspicion of growth, as in a glioma of the optic nerve, being left behind, zinc-chloride paste should be applied, as at p. 265.

Owing to the early stage at which dissemination of intra-ocular sarcomata takes place, and to the tendency of gliomata to creep backwards along the optic nerve towards the interior of the cranium, the prognosis very largely depends upon the earliness of the extirpation. On this account it should be remembered that the earliest symptoms of these growths—viz., impairment of sight from partial detachment of the retina by the pressure of the growth behind it—should be most carefully tested in suspicious cases, this impairment of sight being not usually noticed by the patient, save accidentally on closing the sound eye, unless the growth originates near the yellow spot. If later evidence is waited for, such as evidence of tension and pain, dissemination or recurrence is most probable, while the growth will very likely have perforated the eye, and the severer operation of clearing out the orbit will be required.

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* For an excellent account of these the reader is referred to Mr. Lawson's article, *Dict. of Surg.*, vol. ii. p. 117 *et seq.*

The following questions will very likely arise:—If there is evidence of general dissemination of the disease, is it expedient to remove the eye, or, if this be insufficient, to clear out the orbit as well? In most cases the answer will be in the affirmative, in order to save the patient pain, and the misery of the protruding and ulcerating mass.

If the disease has recurred, is it any use to again attack it? Each question here must be decided by itself. The answer will mainly depend on the amount and depth of the recurrence, and on the completeness of the first operation. Thus, if the eye only was removed at first, it may be wise to clear out the orbit thoroughly.

In a few most distressing cases in children it is well known that both eyes are attacked. The question of operating on the second eye must now be faced. Opinions here differ somewhat. Mr. Butlin [*] thinks that it is better not to operate in such cases, "although the operation may be regarded as justifiable in order to prevent the occurrence of fungous protrusion and the pain and misery which are associated with it." Mr. Lawson,[†] on the other hand, holds that if both eyes are affected, both should be excised. providing that the sight has already been destroyed. He has, on many occasions, removed the second eye to procure temporary relief from the excessive pain induced by the over-distended globe, and when there has not been the slightest prospect of curing the disease. In each case the operation gave immediate and perfect relief.

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[*] *Loc. supra cit.* p. 88.

[†] *Dict. of Surg.*, vol. ii. p. 124.

CHAPTER VI.

OPERATIONS ON THE NOSE.

PLASTIC OPERATIONS FOR THE REPAIR OF THE NOSE — ROUGE'S OPERATION — REMOVAL OF NASAL POLYPI—ADENOIDS OF NASO-PHARYNX.

PLASTIC OPERATIONS FOR THE REPAIR OF THE NOSE (Figs. 56–63).

THESE operations may be divided into those for complete and partial restoration.

Indications.—When the patient is healthy and fairly young, when the cause of the destruction—viz., lupus, gunshot injury, syphilitic ulceration, new growth necessitating removal—is not only checked but soundly healed.*

Thus, after lupus has been cured by scraping, and still more in the case of syphilitic ulceration, it will be well to wait six months at least after the disappearance of the disease.

A. **Operations for Complete Restoration.**—The following will be found the most useful :—

(1) **Verneuil's, by Super-imposed or Double Flaps from Cheeks and Forehead** (Figs. 56, 57).

(2) **Syme's from the Cheeks** (Figs. 58, 59).

(3) **The Indian or Frontal** (Fig. 60).

(4) **The Italian or Tagliacotian.**

Before deciding which operation he will make use of in restoring the nose the surgeon will investigate the following points :—How far is the bony framework of the nose destroyed ? If the cartilages, septum, vomer, ethmoid, and nasal bones are much removed, however well made the frontal flap and however skilfully it is adjusted, it will tend, after looking extremely well at first, to sink down to the level of the cheeks. Verneuil's operation meets this partially by its double layers of flaps. If he proposes to take flaps from the cheeks, the surgeon must examine how far these are plentiful, and free from old scars. So, too, if the forehead is to furnish the flaps, how far is it a capacious one and free from hairs?

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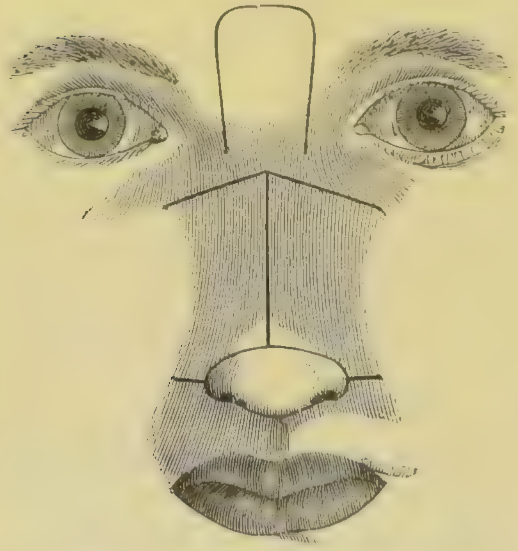
* In Sir W. Maccormac's case, quoted below, the tip and alæ of the nose had sloughed in infancy after the injection of a large nævus with the liquor ferri pernitratis.

The respective advantages of, and the indications for, the above operations will be given in the description of each method.

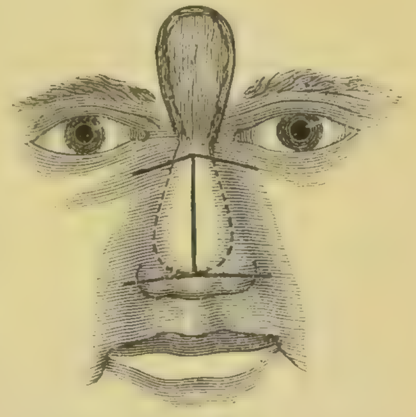
(1) **Verneuil's Operation** (Figs. 56 and 57).—This operation, suggested to M. Verneuil by M. Ollier, was employed successfully by him in order to secure permanent elevation of a sunken nose, by super-imposing two flaps and thereby doubling the thickness. The patient had discharged a pistol into his mouth, destroying a portion of the hard palate and septum, the nasal bones, part of the nasal processes of the superior maxillary, the spine of the frontal, and the anterior wall of the frontal sinuses. The alæ and tip were uninjured, but much flattened; above them was a broad, deep groove, extending to the middle third of the forehead. The principal indication was to rebuild the bridge of the nose. The latter could be permanently accomplished only by filling in the great cavity which would be left by raising the sunken parts.

FIG. 56.



Verneuil's incisions in rhinoplasty for sunken nose. (Stimson.)

FIG. 57.



Verneuil's double flaps *in situ*. The frontal flap is also shown with its raw surface. (Stimson.)

Verneuil made an incision along the median line of the depression and a transverse one at each end of the first, and dissected up the two lateral flaps thus marked out. He then raised an oblong flap from the middle of the forehead, leaving it adherent between the eyebrows, and turned it directly downwards so that its raw surface was directed outwards, its skin surface* looking towards the nasal fossæ. The two lateral flaps were then placed upon it and united in the median line. The raw surfaces united with each other, and the result was a nose elevated $\frac{1}{2}$ inch above the adjoining surface. The wound in the forehead is partly closed by a hare-lip pin and sutures, and later on healed by skin-grafting. The pedicle of the frontal flap will require dividing and trimming subsequently. In addition to the advantage which this operation possesses of rendering a sunken nose prominent, it produces ultimately, from my experience in one case, but little scarring, the lateral incision-scars fading away gradually into the naso-labial sulci, and the folds beneath the eye.

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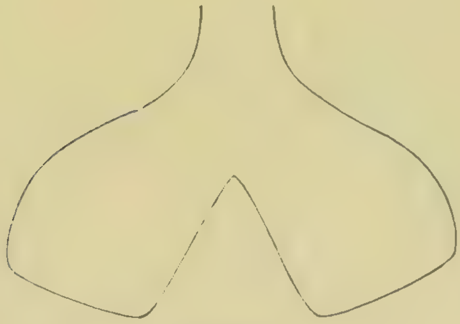
* This should be refreshed. The above account is taken from Stimson's *Operative Surgery*, p. 244.

(2) **Syme's, from the Cheeks** (Figs. 58, 59).—This method is described by its inventor in his *Observations in Clinical Surgery*, p. 56. Besides doing away with a frontal scar, this method enables a nose thus constructed to have its sensations in correspondence with the part from which it was derived.

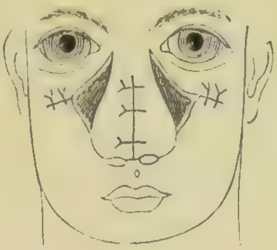
The following drawings show the shape of their flaps, and the manner of their adjustment :—

FIG. 58.



(Syme.)

FIG. 59.



(Bell.)

New flaps of the shape given in Fig. 58 are marked out on the cheeks with their conjoint pedicle above at the root of the nose, between the two inner canthi, extending sufficiently downwards and outwards upon the cheek to secure sufficient ampleness for the new nose, according to careful measurements already taken. The old nose being got ready by careful paring, the flaps thus marked out are dissected up and united in the middle line by three or four sutures, while the outer margins are fixed on each side to the raw surface, at a proper distance from the nasal orifice. Mr. Bell * advises that if any part of the old septum remain, it should be made very useful as a fixed point, a straight needle being thrust through one flap close to its outer lower edge, then through the septum, and out at a corresponding point of the other flap. The edges of the wounds left in the cheeks can generally be partially united by sutures of silver or fishing-gut, and the triangular portion, which must be left to heal by granulation, proves an advantage, as by its depression it enhances the apparent height and prominence of the new organ. The cavity of the new nose may, for the first few days, be kept gently distended with strips of iodoform or sal-alembroth gauze, and later on with small pieces of Jacques' catheter on either side.

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* *Manual of Surgical Operations* (4th edition), p. 176.

(3) **The Frontal or Indian Method.**[*]—This method should be used when the soft parts of the cheeks are insufficient, when they are too cicatricial, or when an operation making use of them has failed. Its chief objections are the large frontal scar, and the liability of the single flap, though abundant and prominent at first, to shrink and fall in later on.

A piece of gutta-percha or leather is so cut that, when folded, it is of suitable shape and size for the new organ; it is then laid, opened out, upon the forehead, and the dimensions marked out with an aniline pencil or tincture of iodine. The flap thus drawn should be of the shape in Fig. 60, and, owing to the retraction of the skin, should measure ¼ inch more than the model in every direction. The average dimensions of the flap are thus given by Mr. Erichsen:[†] when the whole nose requires restoration, it is usually necessary to make it about 2½ to 3 inches long, and from 3 to 3¼ inches wide at its broadest part.

For the frontal flap thus mapped out, a bed is now prepared by paring the old nose into a raw, triangular surface; in doing this the knife must be used obliquely, cutting from without inwards towards the middle line, so as to leave a grooved surface sloping inwards. The warning of Erichsen (*loc. supra cit.*, p. 609) should here be remembered, not to remove the parts too widely, lest the cheeks later on retract and flatten out the nose. The bleeding being arrested by sponge-pressure, torsion, leaving on Spencer Wells' forceps (but not in this case by ligature), and the raw surface covered over with lint wrung out of warm boracic-acid lotion, the frontal flap previously marked out may now be raised. This is done by running a scalpel down to the periosteum, along the traced line, taking care that the pedicle should be sufficiently long to bear a little twisting, and sufficiently broad and thick to secure the presence of one if not both of the frontal arteries. To avoid any risk of stoppage of its blood-supply and sloughing, it is well to place the incision for the pedicle a little obliquely, with one side descending a little lower than the other—viz., on the side to which the flap is to be twisted. Where the level of the hairy scalp admits of it, this flap should lie a little obliquely, the tension being thus lessened. Where necessary, the flap may be taken transversely above one or other eyebrow, but the objection to this is, that the retraction of the scar upon the forehead draws the corresponding eyebrow upwards (Stimson). The frontal flap, however placed, is now raised from below upwards, so that the necessary hæmorrhage is rendered as little embarrassing as possible, and with as little handling, or pinching with forceps as possible. The knife should be kept away from the flap towards the periosteum, and used in the same plane throughout, without any scoring whatever. The hæmorrhage, free at first, is readily arrested by forcipressure (leaving on Spencer Wells' forceps for a while), or by sponge-pressure. The flap being sufficiently raised to hang freely and without tension, is then twisted slightly to one side (that on which the pedicle has been cut longest), and brought down and adjusted to the pared edges below by means of

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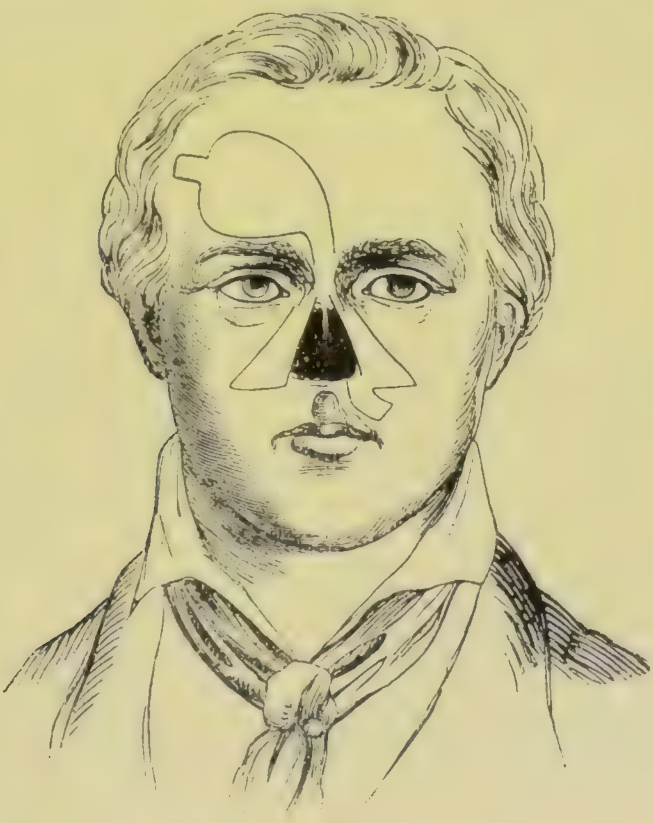
[*] Introduced into European surgery by Mr. Carpue in 1816.

[†] *Surg.*, vol. ii. p. 608.

Fig. 60.



Flaps from forehead. Also flaps from cheeks. (Skey.)

numerous fine sutures of salmon-gut, fine silk, or wire, and horsehair, all being introduced with very small needles.

If the condition of the forehead has admitted of taking a columella from these, an appropriate groove must also have been cut in the upper part of the median line of the lip, and the two carefully adjusted. If no columella can be taken from the forehead the upper lip must furnish it, either now, if the patient's condition admits of it, or later on, when the pedicle of the frontal flap is divided. If no columella is made now, the flap, when attached, must be supported by gently introducing strips of some antiseptic gauze, well coated with eucalyptus and vaseline (ʒj—℥j) ointment. If a columella is made, two bits of drainage-tube or Jacques' catheter are introduced. The parts, being smeared with the above ointment, are well covered in with aseptic gauze or salicylic wool, but in keeping these in position no pressure must be made with bandages on the new nose.

The forehead wound, on which sponge-pressure has been made, is now partially closed with one or two hare-lip pins and sutures, but in introducing these great care must be taken not to constrict the pedicle of the frontal flap. Later on, healing may be here promoted by skin-grafting.

The chief points in the after-treatment are not to change the dressings too frequently, and to use the utmost gentleness in doing so, to remove the sutures gradually, and to be on guard to prevent the onset of erysipelas or of secondary hæmorrhage. The former will be known by a sudden rise of temperature, vomiting, or nausea, and is best treated by warm boracic-acid lotion, applied by a mask of boracic-acid lint and by a sharp purge. Hæmorrhage may occur, according to Erichsen,* as late as the ninth day. It must be met by careful plugging with aseptic gauze, dusted with iodoform and tannic acid.

The flap remains œdematous for some time, but, if not going to slough, it will be found warm and sensitive. If too much swelling persist, leeches or careful scarification should be used.

Separation of the root of the flap.

A month or six weeks later, when the blood-supply to the flap in its new position is established, the pedicle is divided with a narrow straight bistoury and cut somewhat wedge-shaped, with the apex upwards, an appropriate resting-place being fashioned for it in the skin beneath, which, up to this time, has not been touched. The fine sutures already mentioned are then inserted.

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* *Loc. supra cit.*, p. 611, is mentioned a case of Sir J. Lister's, in which hæmorrhage took place, on the ninth day, the patient losing over a pint of blood.

If the patient has been feeble, or if the cheeks are very cicatricial, and thus the new blood-supply to the frontal flap be insufficient, some sloughing may take place, but this is rare.

Formation of a new columna.

If this was not made at the time of the first operation, it should be done at the same time that the pedicle is divided. It is rare that a forehead is sufficiently high to obtain an adequate columna, and the additional thickness and vascularity of the lip make it much more desirable to take one from here. Two assistants, with a finger and thumb at each angle of the mouth controlling the coronary arteries, and at the same time making the parts tense, the surgeon, with a straight, narrow bistoury, transfixes the root of the lip just to one side of the middle line, and cuts straight down through the free border; a similar incision is made on the opposite side of the middle line, and a narrow strip, about $\frac{1}{4}$ inch in width, is thus detached save above. It is well, in a man, to shave off the skin and hair follicles, and the tip being pared, and the remains of the old columna appropriately freshened, the frænum is freely divided, and the new columna united to the remains of the old and to the alæ by one or two fine sutures. The cut surfaces of the lip are then brought most accurately into apposition with a silver wire suture opposite to the coronary arteries and several points of fine silk and fishing-gut. A few more are next inserted to further adjust the columna.

(4) **Italian or Tagliacotian Method.**—This is but very rarely made use of in this country owing[*] to the irksomeness which the needful position entails, and the need of a complicated special apparatus.

On the other hand, the absence of any additional scars on the forehead and cheeks, and the abundant flap which can always be obtained, are so important that it may be thought worth while to try this method in female patients who have sufficient time and means, and who will put up with the inconvenience of cramped restraint for two or three weeks.

Sir W. Maccormac brought a case before the Clinical Society[†] in which this method had answered well in a girl aged sixteen. The following account is taken from his paper. Means for keeping the patient's arm in the needful position for the requisite period were thus provided: "A pair of ordinary stout well-fitting stays were first procured, to which were attached two perinæal straps, to prevent displacement upwards. A helmet, partly made of leather, was connected with the stays by a leather band running up the centre of the neck and back. A leather armpiece, strengthened by a steel band, was moulded so as to extend from the wrist to the shoulder, where it was buckled to the stays. The wrist and hand were fastened to the helmet by a gauntlet, while the elbow could be fixed steadily in any required position by straps running from it to the stays, and to the sides of the headpiece, so that there was nowhere any undue strain, the pressure being so evenly distributed that each strap was almost slack. This apparatus was next applied for some days beforehand, so that any point of undue pressure might be remedied. The girl was able to sleep soundly in it, and it gave promise of proving perfectly efficient. Meanwhile I modelled on the deficient nose a gutta-percha substitute, and from this was able to project on a flat surface the extent of the deficiency. The first part of the operation was performed thus:—A flap was marked out on the inner aspect of the left upper arm, more than double the actual size of the estimated deficiency. The left arm was the one chosen to supply the flap, and the right side of the nose the one first operated on, the septum being fashioned at the same time. The flap was left attached to the upper part of the arm by a broad long pedicle, and so arranged that there should be no traction whatever upon it, whilst the raw surface from which it was taken should be accessible for daily dressing. With the flap I dissected up the subcutaneous fat down to the muscular sheath. Immediate retraction both of the flap and of the denuded part of the arm took place to a large extent, so that the raw surface on the latter was almost co-extensive with the whole inner surface of the girl's arm, the flap appearing quite small in comparison. I now made a slightly curved incision, nearly parallel to the free border of the nose on the right side, and about three lines above it, corresponding, in fact, to where the alar furrow should normally exist. This incision was prolonged some little distance into the cheek in the line of the cheek furrow, whilst the remains of the septum were split open in the median line. This nasal flap could now be turned down so as to become horizontal, or rather a little depressed below the horizontal line, to allow for retraction of the ingrafted piece. A triangular gap, the apex pointing towards the cheek, was thus left exposed on the right lateral aspect of the nose, and into this the triangular-shaped piece from the arm was inserted, and accurately attached by suture, the portion to form the septum being sutured in the groove already formed by splitting the septum. In this way there was no paring of edges, nor was a single particle of nose tissue sacrificed, whilst by having so large a line of attachment, being almost surrounded by living tissue, the new flap was much more likely to adhere satisfactorily in the first instance, and from its freer blood-supply less prone perhaps to subsequent contraction." Union took place in great part by first intention, some suppuration setting in on the eighth day, owing to the indifferent plastic power of the subcutaneous fat. Healing was not complete for nearly three weeks. At this date the operation was completed by detaching the flap from the arm, cutting this so as to give it a triangular shape, and preparing the left side of the nose to receive it in a manner precisely similar to the right. The perfect vitality of the now completely severed tissue of the arm was made apparent by copious hæmorrhage, and healing was complete in a fortnight. After the first forty-eight hours scarcely any inconvenience was felt from the apparatus, save for a slight excoriation on one shoulder. The result was good, but it was expected that further contraction would much improve the aspect of the nose, the new organ being fully large.

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[*] In cases where the destruction is very great, where other methods have failed, where the skin available on the face is much scarred or of doubtful soundness, the Tagliacotian method is especially indicated.

[†] *Clin. Soc. Trans.*, vol. x. p. 181. Three figures are given, of the patient before and after the operation, and of the apparatus used.

Causes of Failure after Complete Rhinoplasty.

1. Gangrene and sloughing. 2. Secondary hæmorrhage.
3. Erysipelas.
4. Destruction of the new nose by recurrence of the old disease.
5. Too large a nose. 6. Too small a nose.

B. Operations for Partial Restoration of the Nose.—These are very numerous, and have usually been designed for special cases. A few only will be alluded to here.

(i.) **Two Lateral Flaps.**—This method is indicated when the lower third of the nose is left untouched and the central portion especially destroyed. (*a*) Small square flaps are raised and united in the middle line (Fig. 61). (β) Another method is shown in Fig. 60. It was made use of by Mr. Skey,[*] who thus describes it :—"In cases in which the ossa nasi are destroyed, the operation consists in bringing to the mesial line two lateral flaps made from the side of the nose upon the cheek. The calculations in this operation are nearly as important as in the frontal method. An incision is commenced at the root of the nose, as nearly as possible on the dorsum, and carried down as close to the line of the former organ as the condition of the skin will permit, and a second, commencing ½ inch on the outer side, should extend downwards, curving at the same time a little outwards, to avoid the orbicularis. The second incision should diverge from the first towards the cheek-bone, and at its extremity, which should correspond with the line formed by the base of the nostril, should be distant more than a full inch from it." Mr. Skey advises that the columella be made at the same time, attached to one of the flaps as shown in Fig. 60. If this fail, the lip will still serve the surgeon's purpose.

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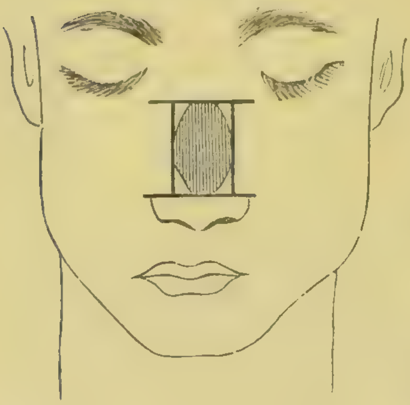
[*] *Operative Surgery*, p. 523.

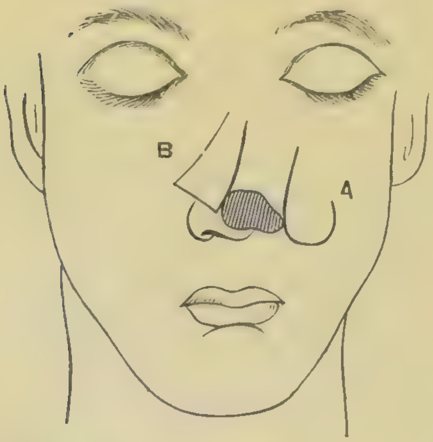
FIG. 61.



Rhinoplasty. Double square lateral flaps. (Stimson.)

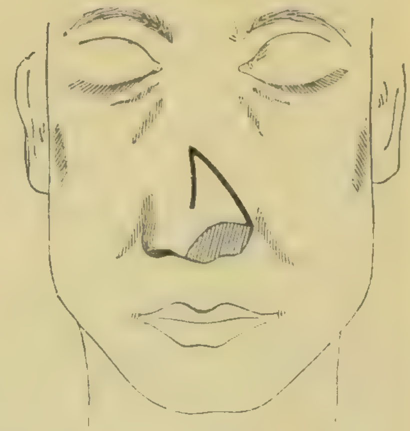
(ii.) **Single Lateral Flap.**—This may be taken in many different ways. (*α*) From the cheek, at the side of and below the nose (Fig. 62, A). (*β*) From the opposite side (Langenbeck), The apex of the flap is left attached to the inner angle of the eye, on the same side as the deficiency, while the base comes from the ala of the sound side (Fig. 62, B). (*γ*) M. Denonvilliers' method. A border that has already cicatrized is made use of so as to prevent subsequent narrowing. A triangular flap is marked out by incisions shown in Fig. 63, the pedicle being internal. The flap, having been carefully raised with a strip of cartilage in its lower margin, is displaced downwards into position.

FIG. 62.



Rhinoplasty. Single lateral flap. (Stimson.)

FIG. 63.



Rhinoplasty. Denonvilliers' method. (Stimson.)

In all the above methods, if cartilage is not included in the free border which is to form the new ala, the flaps should be cut long enough to allow of turning this border upon itself and thus giving a thicker and more natural appearance to it.

(δ) M. Weber's Method. The flap is taken from the upper lip: on account of the hair follicles this plan is best suited to women. An oval flap is taken, usually from the centre of the lip, with its pedicle left attached close to the columna and its free margin reaching to the prolabium. The flap, which consists only of part of the thickness of the lip, is turned up, and stitched to the remains of the ala, which have been refreshed. In three or four weeks this pedicle is divided, and may be so united to the inner surface of the flap as to give it a thicker and rounded margin.*

ROUGE'S OPERATION.†

Indications.—Whenever the surgeon desires to gain free access to the nasal cavities, as in cases of—

1. Intractable ozæna.‡ Thus, when previous persevering treatment, including Thudichum's douche, fails to cure cases of strumous ozæna, with obstinate inspissated crusting of discharge under the turbinated bones; when dead bone is detected by a probe, or is believed to be present in these cases, or, more commonly, in those of syphilitic ozæna. 2. In inveterately recurring nasal polypi, persisting after the steps advised at p. 291. 3. In some cases of naso-pharyngeal polypi—viz., where the growth is small, and where a scar is especially deprecated.

Operation.—An anæsthetic having been administered, the surgeon must decide as to what steps he will take to prevent the blood from getting down into the pharynx. This may be done either by plugging the posterior nares, or by performing laryngotomy and plugging the fauces with a sponge (p. 385). If the hæmorrhage is likely to be troublesome, and the operation prolonged, I much prefer the latter precaution, for I have found that when the nostrils are plugged it is quite possible to sever the silk on one side, owing to its being hidden by clots, and its whereabouts thus not seen. A preliminary laryngotomy followed by plugging the fauces does away with the trouble of plugging the posterior nares and with the presence of silk ligatures in the nostrils.*

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* For the account of these lateral flap operations and for Figs. 61, 62, 63, I am indebted to Dr. Stimson's *Operative Surgery*, p. 240.

† *Nouvelle Méthode pour le Traitement chirurgical de l'Ozène*, par le Dr. Rouge. Lausanne: 1873.

‡ Mr. Hayward (*Syst. of Surg.*, vol. ii. p. 644) believes that in a large number of cases of ozæna the discharge is due to a carious surface being present on the base of the skull. If this view is correct, it obviously points to not putting off this operation too late.

The upper lip having been well raised and everted by an assistant taking hold of it at the angles of the mouth, the surgeon frees it from the upper jaw by an incision through the mucous membrane reaching from the bicuspid teeth on one side to their fellows. In doing this the knife should be kept close to the bones and parallel with them. The cartilaginous septum is next detached from the anterior nasal spine, and the lower lateral cartilages from the upper jaw, the adjacent parts of the cheek being also freed at the same time sufficiently to admit of the nose and lips being lifted up sufficiently to explore the nasal cavities.

After any dead bone has been removed, the sharp spoon applied, and the nasal cavities thoroughly cleansed in cases of ozæna. or any polypi dealt with, the parts are replaced (without sutures), and iced boracic-acid lint applied until the pain and swelling have subsided, and the risk of erysipelas has gone by.

Other operations on the nose—*e.g.*, those of Lawrence and Ollier—are given later on under the heading of Naso-pharyngeal Polypi, pp. 311, 312.

REMOVAL OF NASAL POLYPI.

Some years ago I learnt from Mr. M. Banks his method of clearing out the nose in the most troublesome cases. I have used it since repeatedly with good results, and believe that in its thoroughness, the simplicity of the instruments required, it is far superior to snare, injection with iron perchloride, &c., and the galvanic loop. Of the above, the first is, aided by a 20 per cent. solution of cocaine, an excellent means of getting rid of the larger polypi which come down first, but it is, I think, tedious and inefficient in the case of the crops of the smaller ones, often sessile, which make their appearance later on. I have never found that the abundant hæmorrhage causes any serious trouble, as long as the assistant who administers the anæsthetic knows his business, and as long as the patient's head is kept on one side, over the edge of a table or sofa.

Mr. Banks' method is given in his own words:†—

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* Plugging the fauces after a laryngotomy has the further advantage of leaving the posterior nares free for examination by a finger passed from the mouth, a point of importance in examining these parts, or in manipulations in the case of a polypus.

† *Clinical Notes upon Two Years' Surgical Work in the Liverpool Royal Infirmary*, p. 180.

"As to the most permanently curative operation for nasal mucous polypi, I believe there is nothing equal to the use of the forceps properly managed. Where there are large isolated polypi with well-marked stalks, the wire snare or Dr. Thudichum's process may do well enough, and probably removes them with much less pain than the forceps. But these are not the most common cases. On the contrary, they are usually crops of small growths fringing the superior and middle turbinated bones, which no snare can get hold of, and which in due time make their appearance as large ones. Mr. Syme, after great experience, used to say that the only way was to get one blade of the forceps beneath the turbinated bone and the other on the opposite side of it, and to carry away as much bone as possible. This I always endeavour to do, and find that, along with the big ones, I have brought away whole crops of minute polypi just commencing their existence, which can only be removed by carrying away the bone from which they grow. As to necrosis and all sorts of contingencies which it is said *may* occur as a result of such rough surgery, the simple answer is, They don't occur. On the other hand, the patient has a chance of getting rid of the source of his trouble, and does not need to come every two or three years to have a fresh assault made upon a fresh lot. Failure often results from using forceps which are too big in the blades, and which are only toothed in the points instead of all the way down. In not a few cases where the patient has had several operations performed previously by other surgeons, I have simply smashed up the whole turbinated bone as widely as I could, and so have settled the matter permanently. Now the pain and dreadful sensations produced by this proceeding are more than mortals can bear, and so the patients have had chloroform or ether, and it would be an excellent thing if this were resorted to more frequently. Even a moderate assault with the forceps is a most horrid process, and patients who have gone through it once or twice, will endure any amount of chronic misery rather than face it again. But only a very few surgeons seem inclined to give these unfortunates an anæsthetic, urging as their reasons the danger of blood going down the throat and choking the patient, and the fact that, owing to the patient being insensible, he cannot blow down the nostrils so as to let it be known whether they are clear or not. My plan is to have the patient thoroughly anæsthetized on a sofa. When fully insensible his head should be brought over the edge so that the nostrils are dependent, and then the surgeon, kneeling on the floor, passes up the forceps, and pulls out everything he can till there is nothing more to pull. Meantime, all the blood runs out of the nostrils, and none need go down the throat at all, while the whole time necessary for a thorough cleaning is about a minute for each nostril. I feel convinced that, for certain cases, the only satisfactory cure is to pull away as much as can be got of the superior and middle turbinated bones."

ADENOID GROWTHS OF NASO-PHARYNX.

These growths should be operated on more frequently than is the case, owing to their pernicious effect upon the voice, hearing, and features. They are often a cause of recurrent coryza, and may produce disappointment after the tonsils have been removed. In addition to the symptoms produced by habitual breathing through the mouth only, the finger passed behind the soft palate detects a number of velvety, sessile, or pedunculated masses, not unlike bunches of worms (Meyer). These bleed readily, and block up the posterior nares. As the landmarks are lost, I have found Lennox Browne's advice, to commence by feeling for the septum, and then to explore above and below and on either side of this as a starting-point, helpful. In children they are best removed with the finger-nail passed behind the soft palate. This will also guide a Volkmann's spoon passed through the anterior nares. Or one of the different artificial finger-nails may be used, or Meyer's ring scraper. I prefer these to Löwenberg's forceps. Especial care should be taken in working near the Eustachian tubes, as roughness here may lead to otitis media. The hæmorrhage is free, but ceases spontaneously. Ether should always be given, as this admits of the patient being safely propped up, with the head a little forwards, to facilitate the escape of blood; the child should be in a good light, and a small gag inserted. It is often needful to repeat the operation in a bad case, or where, from a relatively large tongue, great hypertrophy of the tonsils, or much accumulation of pharyngeal mucus, the time as well as the space for operation has been limited; otherwise any remaining growth soon atrophies.

CHAPTER VII.

OPERATIONS ON THE JAWS.

OPERATION ON UPPER JAW.

THESE will include—

i. Removal, partial or complete, for growths (Fig. 64).
ii. Operations for naso-pharyngeal polypus (Figs. 65, 66, 67).
iii. Opening the antrum.

REMOVAL OF UPPER JAW, PARTIAL OR COMPLETE.

Indications.—These include the different growths to which the upper jaw is liable, and opportunity will be taken here to give briefly the chief practical points in connection with these.

1. Epulis.—One of the new growths most frequently met with here. Etymologically gum tumours, these growths vary a good deal. At first, and most frequently, they are simply fibrous, tough and firm, springing from the periosteum, the periodontal membrane, and the endosteal lining of an alveolus. Myeloid cells and small spicula of bone are not uncommon. The longer they are left, the more they are irritated, especially with imperfect attempts at removal, the more cellular and sarcomatous do they become.

Very rarely on drawing the tooth, to the alveolus of which the growth is connected, the epulis comes away completely. Much more frequently it is firmly connected to the periosteum and subjacent cancellous tissue, or the endosteal lining of one or more alveoli. Removal should be early and complete. Shaving off the growth and the gum beneath, and then applying caustics to any suspicious granulations, is most uncertain and unsatisfactory, especially if the presence of teeth is allowed to interfere with the complete removal of the growth, or if this is connected with stumps, and thus dips deeply into an alveolus. By far the best treatment is to draw a tooth in front and behind the growth, and then with a narrow saw to notch the bone at these points deeply through the alveoli: with cutting-forceps a V-shaped or rectangular piece of the bone is then removed. The drawing of teeth not only enables the surgeon thoroughly to eradicate the growth, but their removal leads, as pointed out by Mr. Salter,* to wasting of the alveolus and thus to non-recurrence of the growth. The teeth, if sound, should be preserved, and, later on, when all is firmly healed, fitted to a plate by a dentist. The deformity is thus rendered imperceptible.

In 1884, a captain in the Royal Navy, whose ship was on the North American station, came under my care with an epulis of the lower incisors and contiguous alveolar margin. The teeth were all preserved, and when the parts were soundly healed, Mr. Moon refitted them so skilfully that no trace whatever of an operation could be noticed, and the use of a speaking-trumpet, which was most essential in this case, was not interfered with.

If a patient refuses the only operation which is safe, the surgeon must rest satisfied with shaving off the growth, gouging the subjacent bone, and, if needful, applying caustics to any suspicious patches later on. This course is not only much more tedious and painful, but is uncertain to boot.

2. Fibroma.—These originate either in the periosteum or in the endosteum of the antrum. At first firm, dense, and slow-growing, they may, from the frequent irritation inseparable from their site, become vascular, sloughy, and, taking on more rapid growth, tend to invade the numerous fossæ, fissures, and foramina in the neighbourhood of the bone. They should be attacked early, and while the surgeon may need at this stage to remove only the periosteum and bone from which the tumour springs, especially if it be alveolar in origin, or after opening the antrum to shell out the fibroma completely, he must also be prepared for more radical measures, especially if the growth is of long standing, of late more rapid, if the patient is at all advanced in years, and especially if the growth is recurrent.

3. Sarcoma.—These include the spindle, round, and myeloid varieties, the fibro-, chondro-, osteo-sarcomata, and the rarer form of alveolar sarcoma. While the more slowly growing ones simulate for more innocent growths, such as epulis, the more rapid ones will tax the surgeon's judgment as to whether any operation is justifiable, and all his skill, if removal is attempted. On these subjects the reader is referred to p. 298.

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* *System of Surgery*, vol. ii. p. 456. Mr. Salter also points out that where an epulis forms on an apparently edentulous part of the jaw, the existence of stumps should always be looked for.

4. Carcinomata.—At the present time the softer growths which attack the jaw, and were formerly called medullary cancers, are looked upon as rapidly growing sarcomata. The only true carcinomata met with here are epitheliomata. These are usually of the squamous kind, and commence in the alveolar border in ulceration, beginning in syphilis or the irritation of an ill-fitting tooth-plate. They tend to creep far back and to invade the palate and tonsil; on this account they should be operated on early. Whenever a sore in this position is suspicious in its characters, and obstinate to treatment, whatever be the age of the patient, the parts affected should be widely and freely extirpated. If the growth has eaten into the antrum or has travelled back so as to invade the pterygoid region, removal of the whole bone is most likely to benefit the patient. More rarely a squamous epithelioma attacks the jaw from the lip or face. This happens much more often in the case of the lower jaw. Another epithelioma met with here is the tubular* variety (cylindrical or adenoid carcinoma), which begins in the mucous membrane of the antrum or nose. It is marked by rapidity of growth and invasion of the surrounding parts, and is thus of grave prognosis.

5. Dentigerous Cysts.—These are formed by a collection of serous fluid taking place during the development of a tooth, nearly always a permanent one, which has not come through.†

There are two varieties of these cysts; one, the commonest, is cystic only, consisting of an outer bony shell of varying thickness and an inner membranous one. The tooth may be well formed or a small shapeless calcified mass: its crown usually projects into the sac, vertically or horizontally.

The following points are of practical importance. These cystic swellings may be taken for solid growths, but this mistake may be avoided by remembering that when such a swelling exists there is usually a history of its having commenced in early life, and that though all the teeth may appear to be present, one will very likely be found to be a temporary one. Furthermore, there is the help derived from puncture with a fine trocar.*

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* Mr. Heath (*Dict. of Surg.*, vol. i. p. 857) quotes Réclus as calling this form *epithelioma térébrant*, from its boring or burrowing tendency.

† Mr. Salter (*Syst. of Surg.*, vol. ii. p. 469) gives the following three circumstances as capable of producing impaction of a tooth:—(1) The tooth may be originally developed too deep in the body of the jaw—thus, though it grow in the right direction, it will never reach the alveolar margin; (2) while it may be sufficiently superficial, it takes an oblique direction of growth, so that it lies covered more or less in the axis of the bone; (3) the position of the tooth and its line of growth may be originally normal, but from arrest of the development of the fang it may fail to reach the alveolar edge.

The treatment consists in exposing the surface of the cyst by turning the lip up, or by making incisions through this as small as possible, then in cutting away freely (with bone-forceps aided by a ¾ inch trephine if needful) the walls of the cyst,† so as to examine its contents, and then digging out the tooth, often the most difficult part of the operation. The cavity is then carefully stuffed with strips of aseptic gauze to encourage its granulating from the bottom. If any swelling persist, keeping up deformity, pressure must be trusted to, a Hainsby's truss being here found useful.

In the other variety of dentigerous cysts, solid growth of a sarcomatous nature is present in addition to the cystic. The surgeon here must use his discretion as to opening the cyst, freely scraping out the growth and then applying the cautery or zinc-chloride paste, or removing the bone itself. If the case is of any duration, if the growth is soft and making rapid progress, the latter course will be the wiser one.

6. Enchondromata.—These are rare. They seem to commence in adolescence, usually starting from the surface of the bone, *e.g.*, the nasal, or from the antrum. They should be removed early and completely, as they grow steadily, involving the nose, orbit, frontal sinuses, and thinning the cranial bones.‡

7. Osteomata.—These are rare also. Two forms occur: (1) of the nature of an ordinary exostosis. These are usually cancellous, but ivory ones arise from the superior maxilla as well as from the orbit and frontal sinuses. Occasionally they are symmetrical.§ Their growth is usually slow. If they occur in young subjects they should be attacked while small. The ivory exostoses are occasionally found loose on laying open the antrum, as is the case with those in the frontal sinuses. (2) Diffuse osteomata. These are intermediate in hardness between cancellous and ivory exostoses. They have often broad, ill-defined bases, and

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* Mr. Fearn, of Derby, was candid enough to publish a case of this mistake in diagnosis in the case of the lower jaw, *Brit. Med. Journ.*, August 27, 1864. The specimen is figured in Mr. Heath's *Injuries and Diseases of the Jaws*, p. 162, and shows well how such a mistake might have arisen.

† A good illustration will be found in Mr. Bryant's *Surgery*, vol. i. fig. 194.

‡ Good instances of what these enchondromata may come to are given by Mr. Morgan's case, *Guy's Hosp. Reps.*, 1842; Mr. Heath's *Diseases and Injuries of the Jaws*, p. 237, with an excellent illustration, fig. 107.

§ In Mr. Hutchinson's *Clinical Surgery*, vol. i. p. 11, figs. 3, 4, will be found admirable illustrations of symmetrical exostoses from the upper jaw.

are often multiple and symmetrical. As they tend to produce hideous deformity, and, though slowly, most distressingly, to destroy life, they should be attacked while small. Mr. Pollock * quotes Mr. Stanley † as an authority for the fact that in cases where the whole mass is beyond removal, a portion may be cut away with present, if not permanent, benefit. This can only apply to osteomata of purely hypertrophic nature. Where the bony growth is tipped with cartilage every atom must be removed for the operation to be of any benefit. Well-made osteotomes and drills worked by a dentist's instrument may be of much service here, the great object being to drill a number of holes in different directions through the growth, and then to cut through the intervening bone with well-made osteotomes and a mallet. One of the chief risks is that of intra-cranial inflammation, especially if the growth has involved the interior of the skull.

8. Odontomes.—These are very rare, and usually occur in the lower jaw. They are liable to be mistaken for osteomata or necrosis with anomalous symptoms, as in one occurring in the upper jaw (Jordan Lloyd, *Lancet*, 1888, vol, i. p. 64).

Questions arising before Attempting Removal of the Upper Jaw.

(i.) Is the growth cystic or solid? (ii.) What is the relation of the growth to the jaw? Did it begin on one of the surfaces of the jaw, within the antrum, or behind the jaw? (iii.) Is the growth one, whether malignant or not, that it is wise to attempt its removal?

(i.) **Is the Growth Cystic or Solid?**—A case already quoted, at p. 296, shows that mistakes may arise here. Mr. Heath gives a case under his own care in which caseous pus, after suppuration in the antrum, was taken for a solid growth and the jaw removed. As the diagnosis is evidently most difficult in some cases, the surgeon should, in all cases of doubt, explore first with a trocar and cannula or a drill or bradawl.

(ii.) **What is the Relation of the Growth to the Jaw?**—Did it begin on one of the surfaces of the jaw, within the antrum, or behind the jaw?

In some cases it is quite impossible to be sure on this point up to the time when the flaps are reflected or till the jaw itself is removed; even the use of a finger aided by an anæsthetic is insufficient.

The following points may be useful in aiding a decision as to the relation of the growth to the jaw:—

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* *Syst. of Surg.*, vol. ii. p. 535.

† *Diseases of Bones*, p. 5.

If the growth began on the surface of the jaw—*e.g.*, the nasal or malar process—there will probably be a history of a lump noticed here first, very likely after a blow, and any evidence of the antrum, nose, palate, and orbit being involved will be deferred till late. On lifting up the cheek, masses of growth will very probably be found creeping down between the cheek and gums, but not altering the line or affecting the structure of the alveolus, unless it commenced in it or just above it.

If the growth began in the antrum, the cheek is more slowly swollen, and the swelling is deeper and less defined. The different walls and boundaries of the cavity—viz., the orbital, nasal, facial, and zygomatic—are expanded steadily and with a varying rapidity, while the palate is depressed, and the alveolar border displaced, and the teeth rendered irregular.

If the growth began behind the antrum—*e.g.*, in the basilar process of the sphenoid or the pterygo-maxillary fossa—in many cases a history will be given of polypi removed from the nose or pharynx some time before, perhaps recurring soon; the upper jaw is pushed forwards, and in some cases there is but little alteration in its outward shape, but this is by no means constant. Not unfrequently the upper jaw will be so altered by pressure, its processes—*e.g.*, the malar—so thinned, flattened, and expanded, that it may well be thought that the disease began in the bone itself. And this mistake is the more excusable when it is remembered how easily a growth situated behind the antrum may make its way into this cavity, either by absorbing its walls, or by entering it through the opening into the nose.

If the growth has begun behind the antrum, starting from the base of the skull, symptoms pointing to blocking of the nose—viz., pain here, in the orbit and brow; epiphora from blocking of the nasal duct, interference with nasal breathing, epistaxis, &c. —will most probably be present, yet it must be remembered that many of these symptoms will be brought about by a growth within the antrum increasing rapidly.

It is only, I think, when the surgeon finds no evidence of the growth beneath the skin, or of its originating on the surface of the bone, no depression of the palate, and no irregularity of the alveolar margin or displacement of the teeth, that he can say that the growth is probably behind the antrum.

(iii.) **Is the Growth one, whether Malignant or not, that it is wise to Attempt its Removal?**—While every case must be decided upon separately, and while it would be most absurd and misleading to lay down hard-and-fast rules, the following are not unworthy of attention :—

Favourable Cases.—Growths with a duration extending over many months, hard, well-defined, limited to the jaw, with the skin over the growth perhaps thinned from pressure, and altered in colour, but still movable over the parts beneath.

Unfavourable Cases.—History of a few months' duration; growth soft, vascular, ill-defined; integuments involved and fixed; naso-pharynx invaded; extension into orbit or temple—*e.g.*, soft, semi-elastic swelling noticed behind the malar bone in the temporal region; extension to the sub-maxillary and cervical glands; origin of the growth behind the jaw, rather than on it.

Occasionally, a growth, unfavourable at first sight from its large size, will be found to have protruded on to the face without involving the parts around, and especially those behind.

The history must be carefully examined into. If it be doubtful where the growth began, whether it has invaded or only crept towards the nostril, the surgeon will inquire as to the existence of deep-seated pain, stuffiness in the back of the nose, loss of smell, interference with nasal respiration, epistaxis, &c. Again, the existence of any swelling near the inner canthus will point to extension towards the ethmoid and base of the skull.

Complete Removal of Upper Jaw (Fig. 64).—The patient having been brought carefully* under an anæsthetic, and duly propped up, the face shaved, and the head raised and turned over towards the opposite side, the surgeon takes this opportunity of examining more completely the attachments and limits of the growth, and decides whether, owing to its vascularity, it will be wiser to perform a preliminary laryngotomy and plug the back of the pharynx, p. 385.

The incision, which goes by the name of Sir W. Fergusson,† is then made through the centre of the lower lip (an assistant controlling the opposite coronary while the one in the flap is commanded by the surgeon himself), round the ala, and up along the side of the nose to the inner canthus, and then outwards just below the margin of the orbit, as far as the malar prominence. The flap thus marked out is then reflected, and though no large vessels are cut, the hæmorrhage is often free, especially in cases of rapidly growing tumours which have thinned the bone. Spencer Wells' forceps are applied to the larger of these, while the flap is being reflected these are secured, and an assistant makes sponge-pressure if needful upon the flap to arrest oozing, while the surgeon divides the bones in the following order, the ala of the nose being first detached from the bony margin, and the periosteum of the floor of the orbit freed :—

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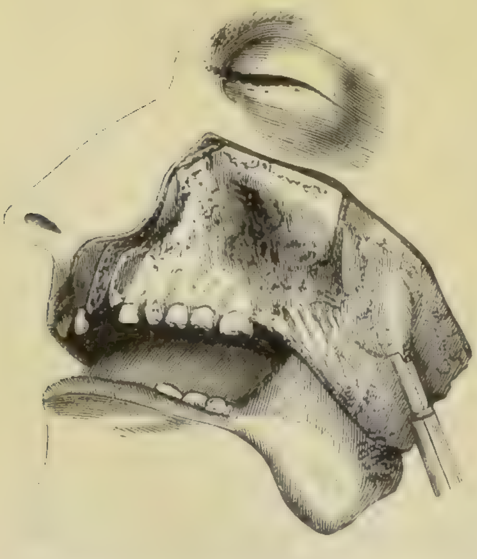
* As in excision of the tongue, the assistant to whom the anæsthetic is entrusted is second only in importance to the surgeon. He should watch most carefully for the first signs of flagging of the pulse, and meet this by injections of ether or brandy. Any evidence of blood going down the throat, dyspnœa (as shown by venous stasis of the cheeks), lividity of the lips, or respiration short and fixed, must also be looked out for.

† First recommended by Dieffenbach. Its advantages are very great—viz., (1) only the terminal branches of the facial nerve are divided; (2) only branches of the facial, not its trunk, are cut; (3) the scar left is much less conspicuous, as the incisions are placed in the natural feature-folds.

(1) The junction of the jaw with the malar bone is divided. The line for the saw is marked out with the knife upon the bone just in front of the origin of the masseter. With a narrow strong-backed saw (Fergusson's or Adams' osteotomy saw) this line is converted into a deep groove and the rest of the bone quickly severed with forceps, the left forefinger placed upon the margin of the orbit steadying these instruments and preventing any damage to the eye. This bone section is practically in a line with the spheno-maxillary fissure (at the lower and outer part of the orbit), and should fall into it.

(2) The nasal process of the superior maxilla is next severed by cutting a saw-groove across it, and then placing one blade of the forceps inside the nostril and the other against the inner angle of the orbit, the soft parts being first a little freed and carefully kept out of the way with the left thumb-nail.

Fig. 64.



Removal of upper jaw. Reflection of flap, and section of bones.

(3) The central or a lateral incisor being next drawn, the mouth is widely opened with a gag, and an incision is made with a stout scalpel along the middle line of the hard palate up to the teeth, and then another transversely outwards at the junction of the hard and soft palate, towards the molar teeth on the side affected. The soft palate is then detached with a scalpel or blunt-pointed scissors, and thus preserved when the bone and growth are wrenched away. The hard palate is then deeply notched with the saw introduced through the nose opposite to the

tooth which has been drawn, and severed with bone-forceps, one blade of which is introduced within the nose, the other into the mouth. If a chisel or osteotome is now inserted into the different lines of bone section, the bone is loosened with a series of quick and careful levering movements, while finally lion-forceps being made to bite firmly into the hard palate and the malar aspect of the bone just below the infra-orbital foramen, the bone is detached by a few wrenching, rocking movements upwards and downwards, and laterally, while the left fore-finger detaches any soft parts which retain the bone, the superior maxillary nerve being cut cleanly with scissors.

When the bone has been much invaded by disease, or in the case of an aged dead body, it is very likely to come away fragmentarily, being unavoidably crushed down by the forceps.

On the removal of the bone, the pterygoid fossæ, the cavity of the nose, and the palate are examined, and the sharp spoon applied to remove any remaining portions of disease, or Paquelin's cautery made use of to destroy any of these which cannot be otherwise removed.

The bleeding is seldom free at this stage, save in rapidly growing cases, as the branches of the internal maxillary are small before they reach the tumour, and, as they are torn through, it is usually arrested by firm sponge-pressure.

If there is any doubt about any of the growth being left behind, some paste of zinc chloride, made up with equal parts of flour, had best be inserted on lint to which silk is attached, the threads being brought out of the mouth through the palate, and so readily removed in a few days. But if the bone has come away with all the growth, if the surface of this is smooth and encapsuled, not ragged or lacerated, the surgeon will do best to insert nothing into the cavity. If oozing is going on, or if there is reason to fear intermediary hæmorrhage, strips of iodoform or sal alembroth gauze should be carefully packed in, and removed later on by the mouth. But it is difficult to keep even these sweet, and the surgeon will do best to dispense with any plugging if possible, and to content himself with brushing over the wound with a solution of zinc chloride (gr. xx–℥j), or with a solution of iodoform in ether. The edges of the wound are then brought together with a few points of silver suture, one or two of these being always inserted in the lip, and others of gut or horsehair, or carbolized silk. Especial care should be paid to adjusting the red line. A little iodoform is then dusted on and gauze dressings with salicylic wool, or a pad of boracic-acid lint wrung out of the saturated lotion, and kept constantly moist, applied.

During the after-treatment the patient should be kept well propped up to facilitate the escape of discharges, which must be prevented from collecting by frequent syringing, or, what is better, by the patient himself often rinsing and gargling his mouth and wound with some antiseptic solution. None of these are more readily used than the old-fashioned potassium-permanganate lotion, and the wound should be occasionally brushed over with iodoform in ether.

In those cases, rare nowadays, where the growth is of great size, owing to the operation being deferred, the mouth may remain open for some days after, but the power over the muscles which raise the lower jaw is gradually regained. The lost sensation is usually restored, and the resulting deformity is often very slight.* Later on, when the parts are soundly healed, the skill of a dentist is called in to fit on a tooth-plate,† and obturator if needful.

Partial Extirpation of the Upper Jaw.—Operations for removal of an epulis with the alveolar border have been described at p. 293, and one for opening up and exploring the antrum is given at p. 318.

If the surgeon find that the lower part only of the upper jaw need be removed, abundant room will be given by dividing the upper lip in the middle line, prolonging this round the columella into the nostril on the diseased side. By detaching the nose and dissecting up the flap of cheek the facial surface of the jaw can be well exposed.

Again, if, after exposing the whole jaw by Sir W. Fergusson's incision, the surgeon find that the orbital plate can be spared, a horizontal saw-cut is made just below the infra-orbital foramen and the bone cut through with a chisel and a few taps of a mallet.‡

When the orbital and nasal parts of the upper jaw are involved

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[*] No skin is, of course, removed, even if it appears to be very redundant; it rarely sloughs, save when the stretching has been extreme, or when it has been needful to apply the cautery to the flap. When the growth has invaded the skin over it, a hideous fistula is left, which must be closed later on, if the patient survives, which he seldom does in these cases.

[†] Mr. Butcher (*loc. supra cit.*, p. 270) in one case preserved the last molar tooth and part of the tuberosity as a fixed point for a tooth-plate, intending to have removed this if the disease recurred in it subsequently.

[‡] The orbital plate should always be left if possible. As Mr. Butlin (*loc. supra cit.*, p. 134) points out, when the floor of the orbit has been removed there often results not only serious disfigurement, but much œdema of the lower lid, and an unhealthy condition of the eye itself, which may be destroyed.

and the lower alveolar portions are sound, these latter may be thus preserved. A cheek flap being reflected by an incision through the lip and upwards to the inner canthus along the nose, the nasal and malar processes are divided while the eye is duly protected. A horizontal saw-cut is then made above the alveolar process, outwards from the nose, and another carried upwards from the outer end of this, to join the incision through the malar process, being made either with the saw or chisel. The piece of bone thus mapped out is loosened with a chisel or elevator, and either prised out with the latter instrument, or wrenched downwards and outwards with the lion-forceps.

Several other operations involving partial removal of the upper jaw are given under the treatment of naso-pharyngeal polypus, p. 313.

Difficulties and Dangers during the Operation.—These have been already alluded to: the chief are—

1. Shock. 2. Hæmorrhage.

3. Breaking down of the bone in the lion-forceps.

4. Outlying pieces of growth either in the pterygoid or other fossæ, or in the temporal region, or far back in the roof of the nose.

Possible Causes of Failure.

1. Prolonged shock. Inability to rally. Besides the usual application of warmth and injections of ether and brandy, feeding by nutrient enemata or by a tube passed by the mouth or by the opposite nostril should be early resorted to, especially in the case of elderly patients, or in those much let down.

2. Secondary hæmorrhage. If this is severe, resisting the use of ice, &c., the wound must be opened up, and if no definite bleeding point be found, firm plugging must be resorted to, either with carbolized sponges dusted with iodoform and tannic acid, or strips of aseptic gauze, with the ends in the wound, wrung out of turpentine. These steps, and pressure on the common carotid, failing to arrest the hæmorrhage, ligature of this vessel or of the external carotid must be employed.

3. Cellulitis and erysipelas. These grave complications are likely to set in when the patient is aged or much broken down in health, with impaired viscera, or when, owing to extensive removal of bone—*e.g.*, having to saw through the zygoma and loosen the outer wall of the orbit, the surgeon opens up deep planes of cellular tissue, which cannot, from the surroundings, be kept aseptic, most troublesome burrowing in the neck probably following. To cut cellulitis short, free scarification with small

incisions should be made use of early so as to unload the parts, and abscesses should be opened at once.

4. Lung trouble. Broncho-pneumonia from inhaling septic matter is here, as after removal of the tongue, a decided risk. In this case, also, the treatment is mainly preventive, by using every endeavour to keep the wound sweet, by the means already given, p. 301.

5. Inflammation of the brain or its membranes.

6. Recurrence.

Mr. Butlin (*loc. supra cit.*) has shown that the mortality after removal of the upper jaw is nearly 30 per cent.—a large mortality, equal to that of amputation of the thigh in the upper half (for disease), or perhaps exceeding it. He goes on to remark that, if we are to reduce this mortality, "we must adopt two courses in the after-treatment—first, such means as will render the wounds aseptic; second, regular and sufficient administration of food."

With regard to the recurrence, Mr. Butlin considers the prospect as very gloomy, only four cases out of sixty-four (in which the result is recorded) being able to be considered successful—*i.e.*, having remained cured for three years.

OPERATIONS FOR NASO-PHARYNGEAL POLYPUS

(Figs. 65, 66, 67).

Attachments and Relations.—The surgeon should consider these carefully before deciding what operation he will adopt for one of these most dangerous growths.

These will vary according to the duration of the polypus. The primary attachments of the growth start by far most frequently from the base of the skull, arising in the thick periosteum covered by mucous membrane which covers in the roof of the nose and top of the pharynx, especially the adjacent parts of the basi-sphenoid and basi-occipital. Less frequently they may arise in the pterygoid fossa and adjacent plates, or from around the posterior nares. Dr. Sands* points out that the region in which a naso-pharyngeal polypus can originate is one of narrow limits, corresponding with the margins of the posterior nares and the summit of the pharynx. It is thus one that can be satisfactorily explored with the finger, and by this means a polypus should be detected in its early stage and removed safely while yet small.

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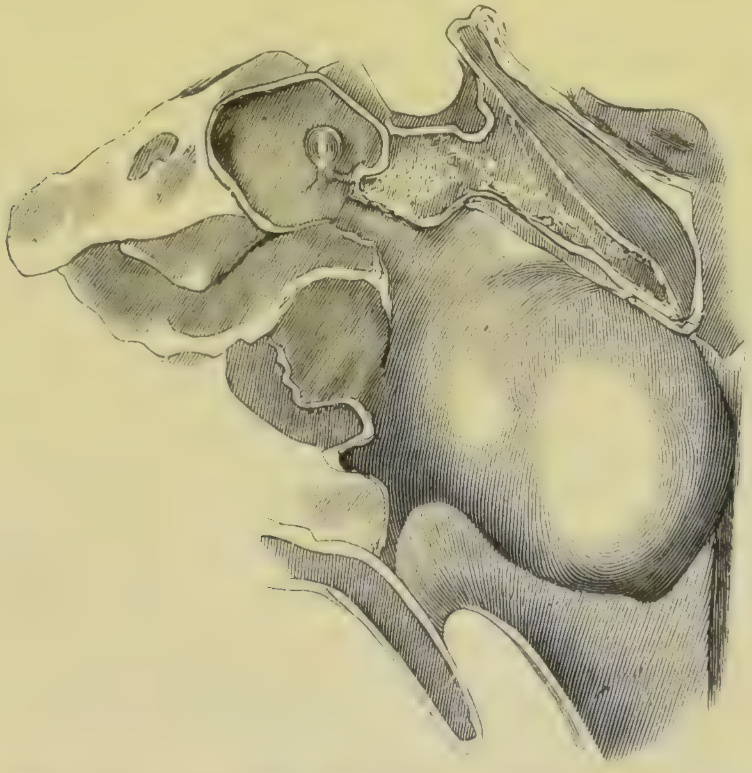
* "On Naso-Pharyngeal Polypi": Dr. Brown Séquard's *Arch. of Sci. and Pract. Med.*, No. 6. According to Dr. Sands, these polypi may also spring from the apex of the petrous bone and the great wing of the sphenoid.

While the above are the most frequent primary attachments of the growths, it should always be remembered that when one of these polypi has existed for some time, when they are sloughy, when previous attempts have been made to remove them—under these conditions the growth is very likely to have taken on secondary attachments. A common instance of these is seen when a growth springing from the base of the skull forms adhesions to the pterygoid fossæ.

If secondary attachments are made out to exist, the next question will be, How far are these intimate and close? How far is the growth not only in contact with, but how far has it actually absorbed bones, such as those of the nose? How far has it got into the antrum, and thus come to resemble closely a growth of the upper jaw? It is obvious that if the growth is mainly limited to the nose, if the bones of this cavity are chiefly affected, it is through the nose that the polypus should be attacked. Again, swelling of the cheek, with protrusion of the eye, will point to an operation, osteoplastic or otherwise, on the upper jaw. In

FIG. 65.



Naso-pharyngeal polypus springing from the base of the skull. In the sphenoidal sinus is seen a smaller polypus. (Massé.*)

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* *Thèse des Polypes naso-pharyngiens.* Paris, 1864.

the same way extension of the growth into the zygomatic and temporal fossæ will render the prognosis unfavourable. Finally, any symptoms pointing to softening of the base of the skull and implication of the membranes—*e.g.*, headache, tendency to coma, convulsions, with evidence of pyrexia, will be conclusive against any operation, even when most carefully performed.

Methods of Removal.—Amongst these are—

(i.) **Avulsion.**—In a few rare cases where the growth is small, where the pedicle is distinct and narrow, and where it not only can be reached, but also commanded (two different things), it may be torn away with suitably curved forceps introduced either by the nose or by the mouth, aided in either case by a finger passed behind the soft palate.

This method is only suitable to the above cases, and in none is without danger. Mr. Cooper Forster's interesting case * is a striking instance of this. Attempts having failed to remove the polypus with a wire loop, Mr. Forster introduced a pair of blunt-pointed strong forceps, and twisted off several large pieces, enough to fill the palm of the hand. These were very adherent, and required a great deal of force to detach them. There was much hæmorrhage. Severe headache quickly followed, then aphasia, restlessness, convulsions, and death on the twelfth day. General arachnitis was found. with sloughy softening of the brain, about Broca's convolution. The growth occupied the left side, filling the space between the greater and lesser wings of the sphenoid, the orbital plate of the frontal, and the cribriform plate of the ethmoid.† From the nasal fossæ it had extended by the sphenoidal fissure into the back of the orbit, but without damaging the optic nerve. The cribriform plate of the ethmoid was broken, there being a small opening at its back part from which a fracture extended forwards. This fracture had doubtless been effected while the growth was being torn away.

The serious hæmorrhage,‡ and the probable incompleteness of the operation, are also strongly against making use of avulsion. Here, as elsewhere, removal of malignant disease piecemeal is most unsatisfactory.

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* *Clin. Soc. Trans.*, vol. iv. p. 159.

† It is noteworthy that though this large growth (Mr. Forster describes it as "an enormous mass around which it was impossible I could get the wire") thus extensively implicated the base of the skull, it only appeared externally as a firm, fleshy polypus filling up a large part of the left nostril, but apparently not pressing much upon the right one. There was no dilatation of any part of the face, no fulness of the palate, nor any projection in the throat.

‡ According to Dr. Sands, Dupuytren lost a case from hæmorrhage after an attempt to remove a polypus by forceps, in which he succeeded in removing only a few fragments. If this method is ever made use of, it might be wise to first perform laryngotomy, and plug the fauces with a sponge.

(ii.) **Ligature.**—This again is only suitable to very few cases—*e.g.*, where the pedicle is distinct and fairly thin, and where the growth has contracted no adhesions. In addition to the probability of return in the pedicle, the fœtor which accompanies the sloughing process is a most serious drawback.* If the ligature were to be used at all, every attempt should be made to get rid of the growth at the time by attaching the ligature after it is placed round the pedicle to a suitable écraseur, and so removing it. Care must be taken in such cases to prevent the growth, when the pedicle is divided, falling upon the larynx.

(iii.) **Galvanic Loop.**—In the very few cases where ligature can be tried, this modification would probably be the best. But even here the pedicle would be left, unless the surgeon possesses special instruments, such as the post-nasal galvano-cautery, and experience in using it.

The following case, which was under the care of Italian surgeons, is reported in the *Syd. Soc. Bien. Retr.*, 1871, 1872, p. 236. Unfortunately, as is so often the case, the result is not given.

The tumour was round, very hard, smooth, and attached by a broad pedicle to the pharynx, the upper part of which it occupied. A Belloc's sound, introduced through the nostril, was passed between the tumour and the uvula; one end of a silk thread was, by means of the sound, carried into the nose, and the two ends of a platinum wire, about 2 feet long and $\frac{1}{20}$ inch thick, were fastened to the other end. The silk thread was drawn through the nose, and, by manipulating the wire loop in the mouth, it was placed as high as possible on the pedicle of the tumour. The ends of the wire were then placed in connection with the battery; the circuit kept closed for twenty seconds, traction at the same time being made on the wire. The current was now interrupted, and the loop, which had cut into the tumour, was placed more accurately on the pedicle. The circuit was again completed, and the tumour was cut through at its base, and removed through the mouth by the fingers. It measured nearly 2 inches longitudinally, and 1½ transversely. The patient felt no sensation of heat during the operation; it was not followed by pain, hæmorrhage, or any discharge.

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* Dr. Sands quotes other causes of death as not infrequent—viz., suffocation from detachment of the growth, pyæmia, and œdema of the larynx.

(iv.) **Electrolysis.**—This method is both most tedious and uncertain. It can only be used as an auxiliary. Thus, Dr. Sands suggests that, after removal of the growth, its pedicle might be successfully treated by electrolysis.

Where patients are weakened by repeated bleeding, the hæmorrhage may be arrested by electrolysis, and the growth sufficiently reduced in size to allow of its being removed through the natural passages. The following case * was under the care of M. Ciniselli :—

The entire wall of the pharynx was found to be occupied by a fleshy swelling which completely blocked up the left aperture of the nares and pressed the epiglottis against the base of the tongue. The starting-point of the tumour could not be discovered. The patient being extremely emaciated and anæmic, any operation involving loss of blood was impossible, and therefore Ciniselli determined to make use of electrolysis. On Nov. 20, 1869, he commenced with a small battery of eight elements. The reophores, of steel, were about $4\frac{3}{4}$ inches long, and were covered with india-rubber to about 1 inch from the ends. The needle of the negative pole was introduced through the left nostril into the polypus, the other through the mouth into the right side of the swelling, and the current was passed through the tumour for fourteen minutes. On Nov. 29, there commenced a discharge from the left nostril of a brownish-yellow fluid containing shreds of destroyed connective tissue. On Dec. 8, respiration and deglutition were more easy. After twenty sittings, the tumour decreased so much that in Oct. 1871 there was only a slight indurated elevation in the posterior inferior wall of the pharynx.

(v.) **Excision by an Operation involving Removal of Bone, Osteoplastic or otherwise.**—These may be divided as follows :—

A. Those through which the attack is made by the mouth.

B. Those by which the attack is made through the nose.

C. Those by which the attack is made by removing the upper jaw, partially or completely, or by resecting this bone osteoplastically.

A. *Operation for Naso-pharyngeal Polypus through the Mouth* (Fig. 66).—This operation was strongly advocated by M. Nélaton.† It consists in slitting the uvula and soft palate exactly in the middle line from before backwards, then prolonging this incision along the centre of the posterior half of the hard palate, going here down to the bone; from the end of this incision two others are made slightly obliquely outwards towards the teeth, also going down to the bone. The flaps, together with the periosteum, are then detached, so as to form nearly rectangular flaps.* Two large holes are then drilled through the hard palate, each well to one side of the middle line, the intervening bone is cut away by placing the ends of cutting-pliers in each of these holes, and, by making lateral cuts back to the free border of the hard palate, a rectangular portion of the posterior half of the bony vault is removed. The mucous membrane and the periosteum on the upper surface of the bone, which will now be found detached, are divided, and, if needful to get more room, more or less of the vomer is cut away. Room being thus obtained, the polypus is removed and its pedicle dealt with. If all the growth is got away satisfactorily, the palate flaps are united in the ordinary way; if further treatment is required, staphylorraphy must be performed later.

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* *Syd. Soc. Bien. Retr.*, 1873–1874. p. 291. M. Ciniselli's wide experience with the galvano-cautery is well known.

† Massé. *loc. supra cit.*, p. 53.

The advantages of this operation, when contrasted with removal of the upper jaw, are at first sight considerable.

(1) There is no deformity left on the face; (2) the parts cut through are less important; (3) mastication is not interfered with by removal of the teeth; (4) the operation is less difficult; (5) the hæmorrhage is less,† no large vessels being cut through; (6) the growth is attacked directly; (7) through the gap thus left the surgeon can again attack the growth, within a few days, if he has been unable to complete the operation, or later on, if recurrence takes place; (8) the gap can easily be dealt with later on by staphylorraphy, or by wearing an obturator.

I am afraid that on closer examination the above will not bear the only true test. The first three are no doubt of great value if the growth can be entirely dealt with by this method; otherwise, considering the malignancy of these growths, the inveterate way in which they recur, if incompletely dealt with, neither surgeon nor patient would be wise in running great risks for the sake of what one may call rather æsthetic advantages.* There is no doubt that, in a few cases, to be mentioned a little later, where the polypus is of moderate size, distinctly pedunculated, and attached low down, *e.g.*, about the posterior nares, or well forward on the base of the skull, the operation will be easier, the hæmorrhage will be less, and the growth will be more directly attached. The advantage of a future staphylorraphy is, like those given first, not of sufficient value to recommend this operation if it is wanting in others more important.

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* This detachment is, as is well known in staphylorraphy, difficult posteriorly, at the junction of the palates, and would best be effected by curved scissors.

† This is very doubtful. Dr. Sands (*loc. supra cit.*), in removing a polypus by this method, had surrounded, without difficulty, the pedicle with an écraseur-chain. This breaking, the pedicle, which was stout and firm, was divided with scissors as close to the skull as possible. Copious hæmorrhage followed, and much time was consumed in unsuccessful attempts to secure a large artery which had retracted to the deepest part of the wound, and which was inaccessible to the ligature. The bleeding finally ceased, in consequence of the prostration of the patient, who had several alarming attacks of syncope. The growth recurring, it was removed by the method of Maisonneuve. Though it was not thought prudent to attempt the removal of a small prolongation which ran into the sphenoidal sinus, no recurrence had apparently taken place nine months later.

Turning to the cases themselves, Dr. Robin Massé has collected twenty-six treated by this method, twelve having been under the hands of M. Nélaton himself. Of these twenty-six, thirteen are said to have been successful, but it is not stated for how long they were followed up. In one case, in which the after-history is given, a small recurrence took place two years later from the pedicle, and was destroyed. While suited to the cases mentioned above, it could scarcely be made use of successfully in large polypi, in the case of those with secondary attachments or large sessile bases, or in the case of those which have extended into the pterygoid fossæ, or, in fact, beyond the naso-pharynx. Save by French surgeons, it does not appear to have been much used, from the belief that the space given is too limited.†

Dr. Sands points out that, in the majority of the cases in which surgeons have operated through the palate, they have had to leave the wound open in order to remove the pedicle later. This step is by no means as easy as might be imagined, and in many cases the surgeon has been driven later to make use of another operation when the patient's condition is less satisfactory.

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* I may here draw attention to the great frequency of these polypi in males, in whom the growth of hair will largely conceal the facial deformity consequent on operations through the upper jaw. In young patients where the mouth is small and the growth large, this operation will be out of the question.

† Mr. Stonham (*Lancet*, January 7, 1888) has recorded a case of naso-pharyngeal polypus, in which "the soft palate was divided in the middle line, and an attempt made to remove the growth through the mouth; but this plan failing to give sufficient room, the nasal cavity was opened up," and the growth thus successfully removed. I have no experience of this operation myself, but I should expect that the bleeding, though from smaller vessels, might, owing to the confined space, and thus a more prolonged operation, almost equal that met with in operative attacks through the jaw, while the vicinity of the larynx makes any hæmorrhage here more embarrassing. Again, in those patients with narrow, highly arched palates, this operation would be accompanied with very great difficulty.

Furthermore, repeated irritation in the shape of attempts at destruction of the pedicle with caustics, the cautery, &c., is too likely to result in rapid sarcomatous growth.*

B. *Operation for Naso-pharyngeal Polypus through the Nose.*—Under this heading will be included:—

(1) Furneaux Jordan's operation.
(2) Rouge's operation.
(3) Lawrence's operation.
(4) Langenbeck's operation.
(5) Ollier's operation.

These operations through the nose are only suited to cases in which the bulk of the polypus is nasal rather than pharyngeal, and in which its pedicle is attached to a point well within reach, as around the posterior nares—for cases, in short, the removal of which might perhaps be attempted, by the use of forceps, by the nose, but in which additional room is required. They may also be used in doubtful cases for exploratory purposes. For other cases, the room which they give, and the access which they afford to the tumour, will probably be found insufficient. Dr. Sands, in speaking of Langenbeck's operation (the only one which he mentions), says that he has found that, after the nasal bone and the nasal process of the superior maxilla have been removed, the distance of the basilar process of the occipital from the anterior opening is nearly 3 inches, and, although the boundaries of the nasal fossæ would, in any given case, probably be dilated by the tumour, the space thus afforded would rarely be found sufficient for satisfactory dealing with the pedicle.†

(1) Furneaux Jordan's operation. I prefer this to any other by the nose. It is extremely simple, most efficient (especially when a growth has dilated the nasal cavities), and leaves most trifling scars. An incision like Sir W. Fergusson's being made along the side of the nose and through the lip, the nose is detached from the bone, and the septum, being cut through, is turned over on to the opposite side of the face.

(2) Rouge's operation. This has already been described at p. 289.

(3) Lawrence's operation.‡ In this, the back of the nasal cavity is exposed and got at by turning up the nose.

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* Dr. Sands points out that the deep situation of the growth, and its position near the larynx, render the use of caustics both difficult and dangerous.

† M. Hergott (*Gaz. des Hôp.*, 1867, p. 97), in the case of a polypus recurrent after treatment by ligature, tried rasping the point of implantation on the base of the skull. He found that an instrument passed through the anterior nares impinged exactly upon this point; the bone was easily denuded, and seven months afterwards no trace of reproduction was visible.

‡ *Med. Times and Gaz.*, 1862, vol. ii. p. 491.

The integuments are first divided on each side of the nose by an incision beginning at a point just internal to the lachrymal sac, and carried down to the junction of the ala and the lip. Next, the incision is completed by cutting through the nasal bones and the nasal process of the superior maxilla with bone-forceps. The septum being now divided, the nose is turned up and the posterior part of the cavity exposed.

(4) Langenbeck's operation through the nose.*

In this the polypus is attacked through the upper part of the nose, by the following osteoplastic operation. The soft parts were first divided by an incision reaching from the centre of the root of the nose obliquely downwards and outwards on one side of the nose on to the cheek, and ending at a point external to the ala nasi. The soft parts on the upper lip of the wound being raised upwards and outwards, a vertical incision was made upwards through the nasal bone to the nasal spine of the frontal, and a second outwards from the bony margin of the anterior nares to the margin of the orbit. The nasal bone and the nasal process of the superior maxilla were then forcibly displaced upwards, together with their periosteum, being still connected with the frontal bone by skin, periosteum, and mucous membrane.

The polypus, which is stated to have been of considerable size, was then easily removed, the bones replaced, and the skin united with a few points of suture. The patient made a good recovery, a lachrymal fistula which formed being closed after some small pieces of bone had exfoliated.

This method has been used several times successfully. Suitable cases have already been indicated (p. 311).

(5) Ollier's operation through the nose † (Fig. 90).

In this method the nose is, by an incision somewhat like the last, only bilateral, turned downwards. M. Ollier begins his incision at the edge of the bone, close behind the ala of the nose, carries it upwards along its side to the highest part of the depression between the eyes, then across, down to the corresponding point on the other side. The bone is sawn through in the line of the incision, the necessary liberating incisions made in the septum and the sides, and the nose turned down. The septum is pressed aside, the polypus extracted, its base of implantation scraped, and the nose replaced.

A modification which is sometimes desirable on account of the size of the polypus, or the distance of its implantation, is indicated in Fig. 90. The incision is made obliquely outwards upon the cheek, and a transverse one is made from each end inwards to the ala of the nose. The bone is divided in the direction of the skin incisions—in the vertical one, as before described; in the horizontal one, by passing a fine saw across the nostrils, through holes made between the bone and cartilages, and sawing outwards. This line of section must be high enough to avoid the roots of the teeth.

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* *Deut. Klinik*, 48; *Gaz. Hebd.*, January 27, 1860.

† I am indebted for the following brief account of M. Ollier's operation to Dr. Stimson's *Operative Surgery*, p. 185.

C. *Operations for naso-pharyngeal polypus by removal of the upper jaw;* (1) *completely;* (2) *partially;* or (3) *by osteoplastic operation on this bone.*

(i.) *Complete Removal of the Upper Jaw.*—This has already been fully considered, p. 299.

(ii.) *Partial Removal of the Upper Jaw.*—These operations are very numerous; one or two will be given as specimens.

a. Method of Maisonneuve* and Guérin† Fig. 66.

Dr. Robin Massé (*loc. supra cit.*, p. 51) states that the so-called operation of Maisonneuve is really that of Guérin, with only a modification in the division of the soft parts. The essential point is to get room for attacking the polypus by removal of the lower part of the jaw. This bone being sufficiently exposed by raising the soft parts over it—and for this purpose the method ot Sir W. Fergusson seems superior to those given by the above French surgeons—the hard and soft palate are then divided in the middle line, and the soft detached transversely on the side to be operated upon. The hard palate is next divided in the middle line by saw and bone-forceps, working from the nose into the mouth. By a transverse section with a narrow-bladed saw introduced into the nose, and made to cut horizontally outwards, the facial aspect of the bone is divided as far as the maxillary tuberosity.‡ The lower part of the jaw is then strongly depressed, and thus detached, consisting of the alveolar and palatine processes, a portion of the body, and a varying amount of the pterygoid processes which usually comes away with it. The polypus is then extirpated.§

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* *Gaz. des Hôp.*, 21 Août, 1860. † *Elém. Chir. Opér.*, 1858.

‡ This section should pass above the roots of the teeth and well below the infra-orbital foramen. Accurately speaking, it was mainly performed, in the hands of its introducers, with bone-forceps.

§ Dr. Sands appends to his paper a photograph of the patient on whom he had operated by this method, after failing to remove the polypus by the plan of M. Nélaton. The deformity is very slight, the malar prominence and the fulness of the cheek being well preserved.

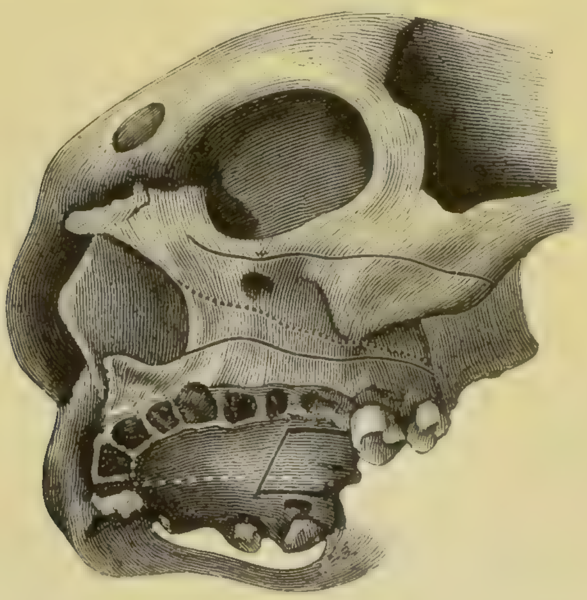
b. Method of M. Bérard.

In this the upper, not the lower, part of the jaw is removed, so as to preserve intact the teeth and alveolar process of the palate.

(iii.) *Osteoplastic Operations on the Upper Jaw.*—In this the bone is cut through by various incisions, turned in different directions on some uncut attachments, as on a hinge, and then fitted down again after the removal of the growth.

Method of Prof. Langenbeck* (Fig. 66).—This is one of the best known of the above operations. Its object is to get at the polypus, especially one in the pterygo-maxillary fossa, without interfering with the alveolar and palatine processes or with the orbital plate. Two semilunar incisions, with their convexities downwards, are made across the facial aspect of the upper jaw, the lower running from the ala of the nose to the middle of the malar bone, the second starting from the nasal process of the frontal and passing just below the orbit to meet the first, where this ended. If needful, owing to the extension of growths backwards, the meeting of these incisions may be carried back along the zygoma. Each cut is made down to the bone, but the skin is not reflected. At the outer end of the lower one the masseter is detached from the zygoma, and if the growth has extended out into the zygomatic fossæ it will now come into view on dividing the buccal fascia. Prof. Langenbeck found at this

FIG 66.



The dotted lines show Maisonneuve's operation, the two continuous ones that of Langenbeck's osteoplastic operation on the jaw. On the hard palate are the lines of Nélaton's operation. Trephining the frontal sinuses is indicated above.

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[*] *Deuts. Klin.*, 1861, p. 281; and Schmidt's *Jahrb.*, vol. cxiii. p. 198.

stage that by pressing the growth to one side and depressing the lower jaw he could pass his finger through the pterygo-maxillary fissure into the spheno-maxillary fossa, and so on through the spheno-palatine foramen into the nose, all these parts being enlarged by the pressure of the growth. By means of a narrow straight saw introduced the same way the upper jaw was cut through horizontally from behind forwards, while a forefinger passed by the mouth kept the tip of the saw from striking against the septum nasi. The saw was now applied along the upper incision so as to divide the zygoma, the frontal process of the malar, and the upper jaw, just below the orbit, up to the inner end of the incision. The portion of the upper jaw thus marked out now only remained attached, at its inner part, to the nasal bone and nasal process of the frontal. Upon these connections, as upon a hinge, the piece of bone was slowly raised by means of an elevator introduced under the malar bone, upwards and inwards, until the malar bone was nearly in the middle of the face. The growth was now completely exposed. The operation took an hour, and was attended with much hæmorrhage, most of which stopped spontaneously. The wounds healed well, a tendency of the bone to rise being met by pressure.

At the present time any surgeon making use of the above operation would wire the bone when fitted down. I would suggest, too, that the incisions through the bones might perhaps, be more easily made with an osteotome and mallet, especially in cases where, the deep parts at the back of the jaw not being so much dilated as in Prof. Langenbeck's case, it is difficult to manipulate a saw and to cut from behind forward.

Prof. Langenbeck's patient was a lad of fifteen. The growth could be felt by the finger in the mouth, filling up the posterior nares on the left side, passing out between the masseter and maxilla; and on this side, too, the zygoma appeared more prominent, and the temporal fossa more full.

This operation seems well suited to growths in the pterygo-maxillary fossa. Its drawbacks seem to be that, (1) if the upper jaw has to be sawn from behind forwards, this cannot be done easily unless the fossæ at the back of the jaw and the spheno-palatine foramen are much dilated; (2) if the growth is mainly limited to the naso-pharynx, this region will not be well exposed unless the pterygoid process is removed as well; (3) very disfiguring scars are left.

The Choice of an Operation for Removal of Naso-pharyngeal Polypus.—The relative values of several of the above operations have already been briefly given. The surgeon will have to weigh duly the following: On the one hand, the desire to get the growth away with as little mutilation and danger to his patient as possible, and, on the other, the fact that these growths are most certainly malignant in nature, and that any partial operation, while probably as difficult and as bloody as one on a larger scale, will, if incomplete, be certain to lead to increased growth in the tumour by the irritation which it causes, while for naso-pharyngeal polypi which come early under treatment, in which the growth is of moderate size (*i.e.*, not larger than a hen's egg), with a pedicle situated well forward in the roof of the pharynx or within easy reach from the posterior nares, especially polypi which can be made out to occupy chiefly the region of the nose, such operations as those of Furneaux Jordan, Lawrence, or the first one of Langenbeck's may be made use of.

In cases of greater difficulty, from the longer duration, more extensive attachments, larger size, and, with this last, the certainty of a more extensive pedicle and numerous large sinus-like vessels, the question of deformity and disfigurement must be entirely set aside.* In order to secure adequate space for making certain of all the attachments of the tumour, for eradicating these, and, at the same time, satisfactorily meeting the hæmorrhage which is usually inevitable, a freer removal of bone will be required. No doubt, for this purpose, removal of the upper jaw would be the best preliminary step. Every surgeon who has performed this operation knows how free is the access which it gives to the back of the nose and to the pharynx. A further advantage, pointed out by Dr. Sands, is the following, that, owing to the wide gap left by this operation, recurrence of the disease can be more readily recognized and treated than after any osteoplastic operation.

But while willingly admitting the great advantages which removal of the upper jaw gives for free exposure of the growth, I cannot quite agree with Dr. Sands,† who recommends this step on the ground that "excisions of the upper jaw are, as a class, remarkably successful operations." On the contrary, I should look upon this as a distinctly serious and grave operation,‡ especially, in patients who, though young, often come before the surgeon with strength reduced by hæmorrhages, dysphagia, and dyspnœa, especially when this is accompanied by attacks of choking interfering with sleep, &c. Any one preferring to get at the growth by some partial resection of this bone, as by the method of Maisonneuve, aided, if needful, by cutting away the pterygoid process and septum,* must remember that the tempting nature of an osteoplastic operation must never weigh too much with the surgeon, especially in cases where rapidity is of great importance, in a patient much pulled down, or where every atom of additional space is required to deal with the base of the growth, or to command serious hæmorrhage.

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* I may again remind the reader that these naso-pharyngeal polypi usually occur in males, often in lads or young adults. The growth of hair which can usually be secured in these cases lessens to a considerable degree the amount of disfigurement which operations on a larger scale entail.

† *Loc. supra cit.*, p. 516.

‡ See the remarks on the mortality of removal of the upper jaw, p. 304.

Dangers and Drawbacks of Osteoplastic and other Operations for Naso-pharyngeal Polypus.—Many of these have been already given under the head of removal of the upper jaw, p. 303; other ones, more particularly to be expected here, are:—

1. Hæmorrhage, not from large arteries, as the internal maxillary, but from the sinus-like veins in the growth itself. To meet this inevitable risk a preliminary laryngotomy should be performed, and the fauces plugged with sponge (p. 384).
2. Meningitis, from damage to the base of the skull (p. 306), or from inflammation spreading to the membranes of the brain.
3. Necrosis and exfoliation.
4. Non-union of a temporarily resected fragment.

TAPPING THE ANTRUM.

This operation is from time to time required for suppuration in the antrum, nearly always in adults, and most frequently after alveolar abscess.

It may be performed in either of the following ways:—(i.) Through the alveolar process. (ii.) Through the facial aspect of the upper jaw, above the alveolar process.

(i.) *Through the Alveolar Process.*—This method has the following advantages:—(α) It drains the cavity at the most dependent part. (β) By withdrawal of the tooth it removes the cause of the trouble. (γ) It does not involve any cutting.

The disadvantage connected with this method is, that, unless special precautions are taken, food tends to enter the antral cavity by the opening made by this method.

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* So as to expose completely any outlying attachments in the pterygoid and zygomatic fossæ, and to get full access to the pharynx and nose.

A tooth has usually to be first drawn, and, as long ago pointed pointed out by Mr. Salter (*Syst. of Surg.*, vol. ii. p. 467), "the tooth whose fangs are most intimately connected with the antrum is the first permanent molar;* and its removal in a case of antral abscess is especially indicated from this circumstance, and from the frail and perishable nature of the tooth itself, which gives it less often than other teeth a long tenure of usefulness." This being done, the orifice made should be enlarged by pushing a trocar up through the alveolus. In doing this the trocar, closed, should be of sufficient size to ensure a free orifice, and, in driving it up through the bone, care should be taken that, when it enters the antrum, it should not plunge against and perforate the orbital plate.

(ii.) *Above the Alveolar Process.*—If the offending tooth has already been extracted, perhaps a long time before, if the alveolar process is largely absorbed. or its remains condensed, it will be preferable to make the opening above. This may be effected by everting the cheek, incising the mucous membrane, and thus exposing the bone above the position of the second molar tooth, and then perforating here with a gimlet, drill, stout trocar, or, as Sir B. Brodie suggested, with a strong pair of scissors, held closed in the hand and bored into the bone with a twisting movement.

Where the bone is much condensed, the instrument used in perforating will be held so tightly that the surgeon will need to withdraw it once or twice and use a probe before he can make certain of having opened the antrum.

The antrum having been opened by one of the above methods, the chief objects are, getting and keeping sweet the cavity of the antrum and preventing any food making its way in here, while at the same time the artificial opening is kept patent.

To ensure these ends frequent syringing through a gum-elastic catheter or an Eustachian catheter must be made use of, the lotion used being mercury perchloride, carbolic acid, iodine tincture, potassium permanganate—the lotion itself not being of so much importance as the assiduous frequency with which it is used. After a while, when the discharge is no longer offensive, and no inspissated putty-like stuff comes away, some such astringent as silver nitrate (gr. 1 or 2—℥j) may be used.†

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* Any other tooth, as Mr. Salter advises, molar, bicuspid, or canine, whose disease is possibly the cause of the abscess, will, of course, be extracted, as absorption round any carious tooth facilitates perforation of the alveolus.

† The patient should be warned at the commencement how very tedious these cases are, and told of the need of persevering and patiently prolonged treatment.

To prevent the entrance of food, and at the same time to keep the opening patent, a short tube should be worn, let into a plate fitted over the perforation. Through this tube the patient can readily syringe out the cavity, and by the insertion of a small plug of cork at meal-times the entrance of food can easily be prevented. When there is no longer any need to keep the artificial opening patent, removal of the short tube and plugging the hole which held it will facilitate, by excluding air, saliva, &c., the closure of the antral opening. If this is still tardy, it may be hastened by the careful application of the cautery.

REMOVAL OF THE LOWER JAW, PARTIAL OR COMPLETE.

Indications.—These are much the same as those already fully given for removal of the upper jaw, p. 293. Mr. Butlin (*Oper. Treat. of Malig. Dis.*, p. 137) has treated of these growths, and has pointed out that here important differences are observable between the central and sub-periosteal sarcomata. Thus the central (most often myeloid) sarcomata grow slowly, the sub-periosteal quickly; the former are encapsuled, and even when they make their way into the surrounding structures they do not show that tendency to infiltration which is so marked in the sub-periosteal sarcomata. The central ones are rarely associated with affection of the lymphatic glands, or with secondary growths.

The following operations will be considered:—

A. Partial removal of the lower jaw.
B. Complete removal of one half of the lower jaw (Fig. 67).
C. Complete removal of the jaws, upper or lower.

A. **Partial Removal of the Lower Jaw.**—This is frequently required in the case of epulis. The steps are the same as those given already at p. 293. The alveolar border should always be removed; in the case of a growth very far back around the lower molars it is quite justifiable to slit the cheek, especially if the growth is becoming doubtful in character, and thus requires thorough extirpation.

The above remarks still more hold good in the case of a growth about the gums, situated far back in an older patient, and becoming epitheliomatous.

Cases are occasionally met with where, owing to an epithelioma of the lip not having been treated, or to its recurrence, the symphysis of the jaw is infiltrated and requires removal. The soft parts being reflected by incisions on either side of the diseased parts converging towards the hyoid bone, and the vessels secured, the bone is sawn through in two places* well beyond the level, where its softened, spongy state, and the loosened teeth, show that it is invaded. The tongue, prevented from falling back by a loop of silk passed through its tip, is now detached by snipping through the mucous membrane, and the muscles attached to the genial tubercles. Any further hæmorrhage being looked to, the sub-lingual and sub-maxillary glands are examined, and, together with any enlarged lymphatic glands, removed if needful; flaps are dissected up from the neck to make a new lip (p. 343, Figs. 80, 81); and drainage provided, the tubes being brought out below at the lowest level of the region from which the flaps have been dissected up. The adjustment of these to form the new lip will be the more easy in proportion to the amount of bone removed.

So, too, occasionally in epithelioma of the angle of the jaw, primary, or secondary to that of the tongue, the surgeon may be led, in order to relieve his patient's condition, if he cannot cure him, to operate extensively here. Thus, after turning up a horse-shoe-shaped flap, with the concavity upwards, and clearing the masseter off the jaw, this bone is divided above the angle, then through the horizontal ramus, and removed, together with the sub-maxillary, sub-lingual, and lymphatic glands, which will probably be enlarged, and also adherent. The hæmorrhage will be free from the facial and lingual vessels, and veins communicating with the external jugular. Free drainage must be provided.

Removal of part of the horizontal ramus or of the angle may be called for in cases of new growths limited to these parts, and the surgeon may, especially in the case of women, ask how far it is worth while to try and remove these from the mouth, detaching the soft parts with a raspatory, and sawing the bone in front and behind the growth, as in the case of an epulis, but the section here passing through the whole thickness of the jaw. Mr. Maunder on two occasions removed large portions of the bone in this way. The following remarks of Mr. Heath (*Dict. of Surg.*, vol. i. p. 837) should be carefully considered before the surgeon, for the sake of saving a scar which will be very little noticed, under-takes a much more difficult operation, and one which, owing to the limited space it gives, may tend to his working dangerously near the growth :—"The principal difficulty in these operations was not so much the separation of the tumour, as its 'delivery' through the mouth, which was slightly split in one instance. Fortunately the hæmorrhage in both cases was slight, and the patients did well; but another surgeon was less fortunate, and lost his patient by secondary hæmorrhage, but, considering the close proximity of the facial artery, and the necessary division of the inferior dental artery, this is not to be wondered at. It may be doubted if the extra trouble and risk of the proceeding are balanced by the absence of a scar, which, in the majority of cases, need not involve the lip, and if properly placed, will be nearly invisible afterwards."

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* Mr. Heath (*Dict. of Surg.*, vol. i. p. 839) gives the following practical hint with reference to dividing the jaw in two places:—"In making these sections it is better not to complete one before the other is begun, because of the loss of resistance consequent upon breaking the continuity of the bone, but each cut being carried nearly through the bone with the saw may be conveniently finished with the bone-forceps."

Question of removing a Portion or the Whole of one Lower Jaw.—This matter will have to be decided when the surgeon, having a case of growth before him which involves the horizontal ramus as far back as the angle, is in doubt as to whether to saw through the vertical ramus or to disarticulate. In the great majority of cases, especially where the patient is no longer young, where the growth is not a central one, where it has been attacked before, the operator had much best place his patient and himself on the safe side and disarticulate. The lower jaw being "a floating bone" this radical step often gives a better prognosis for operation here than in the case of the upper jaw. On the other hand, the lower jaw is so embedded in soft parts, and so near to important parts—*e.g.*, pharynx and pterygoid fossæ—that delay may render the extirpation of the growth impossible. I would refer my readers to two cases in which, after partial operations even in Mr. Heath's hands (Hunt. Lects., *Brit. Med. Journ.*, June 18 and July 2, 1887), fatal extension and recurrence of the growth took place.

B. **Removal of Half of the Lower Jaw** (Fig. 67).—The patient's shoulders being supported, and a preliminary laryngotomy performed if the growth is so vascular as to make plugging of the fauces a wise precaution, the surgeon, standing usually on the same side, makes an incision from just below the lip* down through the tissues on the side of the chin, then along and below the border of the lower jaw to the angle, and then up to a little below the lobule of the ear. The finger of an assistant is

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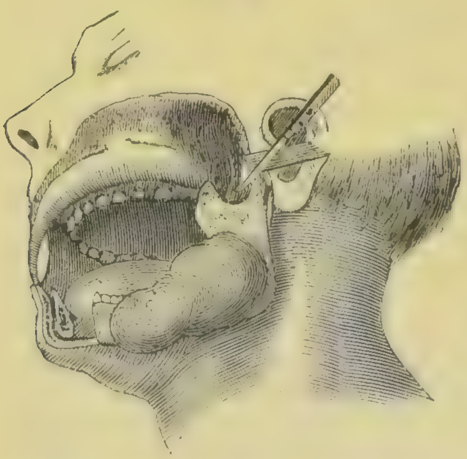
[*] If there are reasons for especial speed, such as the condition of the patient, or if the growth is very large, the red border should be divided, as this facilitates matters much, and the additional deformity is very slight.

placed on the facial artery as soon as it is cut in this incision, and when it is completed the ends should be tied or twisted at once. The flap thus marked out is raised upwards, the masseter going with it if sound, and the cavity of the mouth opened by dividing the buccal mucous membrane at its junction with the alveolar border. An incisor being extracted if needful, the jaw is divided to one side of the symphysis well in front of the growth, by means of deeply notching it with the saw* before using the bone-forceps. If it be needful to remove the bone so freely that the symphysis and the genial tubercles are removed also, the tongue must be carefully prevented from falling back upon the larynx by means of a loop of stout silk passed through the tip. The bone being divided and pulled outwards the knife is passed along the inner side of the jaw so as to detach the mylo-hyoid, with perhaps the digastric and the mucous membrane, and, at the angle, the internal pterygoid. In doing this the knife should be kept very close to the bone so as to leave behind the sub-maxillary gland.

FIG. 67.



The anterior half of the jaw being thus freed, the surgeon, taking it in his left hand, everts it so as to divide the internal pterygoid more freely, and also the inferior dental nerve and vessels. The jaw is next strongly depressed so as to bring down the coronoid process, and the insertion of the temporal muscle. This strong tendon requires complete division, as depression of the bone brings fasciculus after fasciculus into view. If the coronoid process is very long it may hitch against the malar bone or be jammed against it by the bulk of the tumour: in such case it had better be cut off with bone-forceps, and, after the removal of the growth, dragged down with sequestrum-forceps and removed. After the temporal tendon is thoroughly detached (when this is effected the jaw comes down more easily), strong depression of the jaw is continued so as to bring the condyle within reach, no eversion or rotation outwards of the bone being

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[*] When the condition of things admits of it, the jaw should always be divided as far from the symphysis as possible, in order to preserve the anterior belly of the digastric and its insertion, which will thus counteract the tendency of the muscles on the opposite side to draw the chin somewhat over. It is convenient to be provided with a saw with a movable back.

permissible at this stage of the operation, or the internal maxillary artery which passes between the neck of the jaw and the internal lateral ligament will be brought into the wound, and very likely cut, causing profuse and troublesome hæmorrhage. The inferior dental nerve and vessels being divided, and the external pterygoid fibres partly torn through with the finger or the director, the capsular ligament is opened in front with the careful use of the point of the knife, which next, kept close to the bone, divides the lateral ligaments, when the jaw comes away, the final separation being usually effected by the remaining fibres of the external pterygoid being torn through, together with the stylo-maxillary ligament and the periosteum to which it is attached. The knife, if it is required here, should be kept very closely in contact with the posterior border of the ascending ramus.

If the internal maxillary artery has been divided, which is sometimes excusable in cases of large growths extending far up, it can be readily secured in the large wound.

If the operator finds the vertical part of his incision insufficient, and yet does not like to prolong it for fear of damaging the chief part of the seventh nerve, the soft parts should be forcibly dragged upwards with a retractor, after being pushed upwards with the handle of the scalpel.

In cases where the jaw has been extensively thinned or eroded by growth it is very likely to fracture under the depression which is required to bring down the condyle. If this accident occur, removal of the condyle and coronoid process is rendered difficult, as the latter is drawn upwards under the zygoma by the temporal muscle. Their removal will be facilitated by dragging them down with lion-forceps and detaching the temporal tendon with blunt-pointed scissors. If the growth is wedged in firmly above the soft palate, the chief mass should be removed by cutting through the upper part of it, and sawing through the ramus just below the coronoid process. The part of the jaw thus left is then disarticulated, and the rest of the growth removed.

All hæmorrhage being arrested by ligature or sponge-pressure, any enlarged glands, including the sub-maxillary if affected, are removed. The flap is then brought down and adjusted with one or two points of silver suture and sutures of horsehair, gut, or carbolized silk, drainage being first provided for by bringing a drainage-tube from the neighbourhood of the condyle through the wound below. Iodoform and collodion is then brushed over the wound.

Especial care must be taken in exactly uniting the red line of the lip if this has been divided.

The wound is then dressed, as at p. 301, and the patient here also should be propped up to facilitate escape of the discharges. For the first few days it may be well to feed by a nasal tube, or by rectal enemata and suppositories. The patient should wash his mouth out, as frequently as possible, with Condy's fluid.

Difficulties and Possible Mistakes during the Operation.

1. Slipping back of the tongue, if the symphysis has been removed.

2. Wound of the pharynx by not keeping the knife close to the bone in separating the soft parts from the angle of the jaw. This interferes with the patient's being able to swallow from the very first.

3. Fracture of the jaw.

4. Jamming of the coronoid process.

5. Rigidity and permanent contraction of the temporal, masseter, &c.

6. Wound of the internal maxillary vessels.

7. Outlying growth in the temporal region, or near to the tonsil and large vessels.

C. Operations for Complete Removal of Both Jaws.*

Before leaving the subject of removal of the jaws, a few words may be said of those rare cases which occasionally call for removal of both the upper, or the whole of the lower jaw, or both the jaws on the one side.† My space does not admit of my doing more than giving brief references to a few cases. The chief conditions calling for such extensive operations are phosphorus necrosis in the case of the upper or lower jaws. The diminishing frequency of this disease is well known; where the whole of the upper or lower jaw requires removal, half should be taken first, and the operation should be conducted, as far as possible, subperiosteally and without skin incisions.

The growths which call for removal of both upper jaws, simul-

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[*] It is not always easy to tell the limits of a jaw-growth. Thus one of these may extend up to the level of the lower part of the ear, bulge forwards close up to the nose, creep low down in the neck, and yet originate in the lower jaw. In deciding to which jaw a growth belongs, attention should be paid to involvement of the floor or roof of the mouth, and the results of masticatory movements.

[†] Mr. Spanton (*Brit. Med. Journ.*, 1885, vol. ii. p. 64) records a case in which first the upper and a few months later the lower jaw on the right side became the seat of malignant disease. The jaws were removed at an interval of a week. The patient, aged fifty-five, recovered from the operations, but the lower growth quickly recurred.

taneously, fall mainly under the two heads—(*a*) Epithelioma of the palate and alveoli involving one or both of the antra;* (β) Growths, usually sarcomatous, springing often from the base of the skull or some part of the naso-pharynx, and projecting forwards the jaws with hideous deformity.† These cases are much less favourable than the epitheliomata.

In either case the parts are exposed by slitting the centre of the upper lip and then carrying the incision round the nose on either side, Fergusson's incision being made use of as far as needful. In some cases, in order to get adequate room, it may be needful to make incisions from the angles of the mouth to the malar bones, and raise all the intermediate soft parts as a flap. Wherever it is feasible, as in cases where the growth has begun in the alveolar processes, the infra-orbital plates should be retained. This may be done by sawing through both bones from the nose outwards, and completing the separation of the lower part of the maxillæ from the upper by an osteotome or chisel. After the full account already given of removal of the upper jaw no description need be given of these operations for removal of both halves simultaneously. The greater risk of shock, the liability to more profuse hæmorrhage, the probability of finding the growth extending far back into the different fossæ, and along the base of the skull, are obvious. Later on, if the patient make a good recovery, the help of a dentist will be much needed in fitting some form of obturator, as articulation is now much more imperfect.

Question of Gouging, &c., in preference to Partial Removal of the Jaw.

The treatment of dentigerous cysts, if simply cystic and uncomplicated by growth, by measures short of removal of part of the jaw, has already been given (p. 296). Treatment on the same lines—viz., extraction of teeth, freely opening up the cyst by cutting away part of its walls, turning out its contents, and then obliterating it thoroughly by vigorous gouging wide of the disease —has been tried in other cases, especially in those cases of cystic disease, more common in the lower than in the upper jaw, the multilocular variety of which has been termed by Mr. Eve "cystic epithelial tumours." This so-called "enucleation" should be adopted with the greatest caution. In young patients with cysts and fluid contents and no intra-cystic growth the above method is permissible, as it leaves no deformity. These cases will always require careful watching afterwards. Where there is any solid growth, neither gouging nor enucleation is permissible.* Their use is to be condemned in the strongest terms in anything approaching to the periosteal sarcoma.†

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* Godlee, *Clin. Soc. Trans.*, vol. xx. p. 260.

† Lane, *Lancet*, January 25, 1862; Dobson, *Brit. Med. Journ.*, October 11, 1873.

OPERATIONS TO RELIEVE FIXITY OF THE LOWER JAW (Fig. 68).

SUTURE OF DISPLACED FIBRO-CARTILAGE.

The above condition may be due either to changes in the temporo-maxillary articulation resulting in ankylosis, or to cicatricial bands between the jaws, or to both.

Operations.—The two usually performed are:

(i.) Excision of the condyle, an operation indicated when the mischief is limited to the joint itself.

(ii.) Esmarch's operation of removing a wedge of bone from the horizontal ramus in front of the cicatrices and masseter, this operation being preferable to the first when scars are present which interfere with excision of the condyle.

Conditions justifying One of the above Operations.—Inability to open the mouth, resisting use of wedges, &c.‡ Fœtor of saliva and breath. Difficulty of speech. Inability to eat solid food. The above are brought about by the following causes, which will be enumerated together here, though some call for one of the above operations and some for the other—viz.:

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* Mr. Lawson brought before the Clinical Society (*Trans.*, vol. vi. p. 20) the case of a man, aged sixty-five, in which he succeeded, by excision and application of zinc-chloride paste, in removing an epitheliomatous growth of the upper jaw fungating through the skin of the face. The growth recurred twice during convalescence, and on each occasion an anæsthetic was given, and the actual cautery and the zinc-chloride paste applied. Mr. Lawson points out—(1) that patients advanced in life stand large cutting operations, such as the complete removal of the upper jaw, very badly, whilst they will bear with but little shock the destruction of large growths by escharotics; (2) that the treatment was accompanied with very little pain; (3) that the deformity produced by such an operation is much less than that after an equally efficient operation by the knife which would have involved cutting widely of the growth. It is to be regretted that no details are given of how the growth was excised, nor of how much of the bone was removed. Furthermore, the report is only carried on four months after the patient's leaving the hospital.

† An instructive case of sub-periosteal sarcoma which was three times treated by gouging—rapidly recurring each time—and twice by removal of parts of the jaw, is given in the *Lancet*, 1889, vol. ii. p. 1168. Death took place from a recurrence in the floor of the mouth within seven months of the first operation. Those familiar with surgical literature will recall many similar cases.

‡ Mechanical apparatus must be used early to do any good. Daily forcible use of levers is usually unsatisfactory, and the use of interdental shields can do little more than retard scar-formation.

1. Inflammation of the joint set up by a punctured wound,* gonorrhœal arthritis, severe contusion† or sprain, osteo-arthritis,‡ or suppurative arthritis, from abscesses burrowing into the joint, *e.g.*, abscesses connected with otitis media.

2. An unreduced dislocation in which much stiffness remains after attempts at reductions have failed in a patient healthy and not advanced in life.

3. Cicatrices after sloughing set up by scarlet fever, measles, typhus, cancrum oris, or mercurial stomatitis.

4. Cicatrices after suppuration due to necrosis or alveolar abscess.

5. Periostitis of malar after suppuration, fixing the condyle to the inner surface of the zygoma (Heath, *Brit. Med. Journ.*, 1884, vol. ii. p. 1191).

Excision of the Condyle (Fig. 68).—This operation is indicated when the mischief is limited to the joint itself, as in the first two conditions given above.

It may be performed as follows:—

An incision about 1½ inch long is made on a level with the tragus along the lower border of the zygoma. The parotid and branches of the facial nerve being drawn down, the masseter fibres are cleared away from their insertion with a narrow elevator, and the joint exposed. The neck of the condyle is now sawn through with a fine saw, or divided with an osteotome, and the condyle turned out with an elevator, the external pterygoid being detached. The fibro-cartilage is left behind. The bone, which must not be splintered, may require further paring down, and the operation need repeating on the opposite side before sufficiently free movement is regained. After the operation the mouth should be opened with a gag to a full inch, more it possible, and this should be frequently repeated with the aid of nitrous oxide or ether, and the case watched most carefully owing to the frequency with which relapses take place.*

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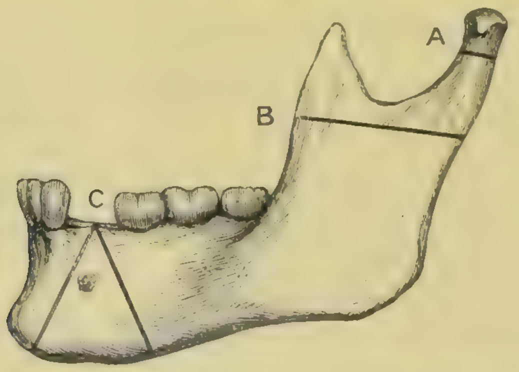
* *Cf.* Mr. Hilton's case (*Rest and Pain*, p. 114), in which bony ankylosis of this joint, and of the upper cervical vertebræ, seemed to date to a punctured wound in the neck.

† Mr. Heath (*R.C.S. Lects.*, 1887, vol. ii. p. 114) mentions a case in which ankylosis of the temporo-maxillary joint followed on a kick from a horse on the side of the face. In such cases a fracture may co-exist.

‡ Good illustrations of this condition are given by Mr. Heath (*Brit. Med. Journ.*, 1887, vol. ii. p. 55). The fibro and articular cartilages will probably be wanting. See also Prof. Humphry's case, *A Report of Some Cases of Operation*, pamph., 1856.

In severer cases it will be advisable to remove more bone, and thus leave a wider gap. Thus, Dr. Mears (*Amer. Journ. Med. Sci.*, 1883, p. 459) relates a case of closure of the jaws after gunshot injury, successfully treated by removal of condyloid and coronoid processes, and division of the masseter and temporal as well as the external pterygoid. The incision was made along the lower border of the malar and zygoma, the origin of the masseter turned down, and the bone cut through with forceps. Dr. Mears considers that this method has the advantages of being applicable to all cases, and of giving better results. It has also been practised from within the mouth, a director being first used to clear the way: this method runs the risk of causing serious hæmorrhage at once and later, in a region difficult of access. A little facial paralysis, usually temporary, is often present after removal of the condyle. After more extensive interference with the soft parts, there is a greater risk of its being permanent. Another mode of treatment which should only be attempted in early and uncomplicated fibrous ankylosis, is *subcutaneous division of the contracted structures round the joint.* Mr. Spanton (*Brit.*

FIG. 68.



A, Excision of condyle. B, Excision of coronoid and condyloid process. C, Esmarch's operation. This must always be in front of all cicatrix-tissue. It happens to correspond here to an edentulous part of the jaw.

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* I may here quote some remarks made in my article "On Injuries of the Face" (*Syst. of Surg.*, vol. i. p. 728) when discussing the causes of the early and marked fixity of the jaw after an unreduced dislocation. "It is more probable that the displaced coronoid process and the neighbouring parts of the ramus become quickly embedded in inflammatory products, which in this region especially are so rapidly effused, and which here so soon undergo at least partial organization, leading perhaps not only to fixity of the displaced condyle and coronoid process, but also to filling up of the glenoid cavity. This consolidation of effused inflammatory products will be hastened by the patient, owing to the pain, keeping his jaw as quiet and fixed as possible."

Med. Journ., 1887, vol. ii. p. 59) has adopted this step with some success in two cases. A blunt-pointed tenotome should be tried for the deeper work. After operations here, owing to the tendency to rapid effusion, the best dressing will be hot boracic lotion and boracic-acid lint with a little iodoform. To prevent recurrence of the stiffness, every means should be taken to get rid of the swelling as soon as possible. If hæmorrhage occur, pressure with aseptic gauze must be made use of.

Esmarch's Operation (Fig. 68).—Where the fixity is brought about by cicatrices within the mouth rather than by mischief limited to the joint, removal of a wedge-like piece of bone, in front of all scars, is to be preferred. Division of the bands inside the mouth is absolutely futile, and attempts to cover the wounds, made by excision of scars, with flaps of mucous membrane or skin are difficult, bloody, and disappointing.

An incision 2 or $2\frac{1}{4}$ inches long is made along the lower border of the jaw in front of the masseter and cicatrices. This incision should go down to the bone: the facial artery will probably need securing. A triangular wedge of bone is then removed with a narrow saw and bone-forceps. The sections should be made as cleanly as possible to avoid risk of necrosis, and the periosteum should be removed with the bone. The wedge should measure at least $1\frac{1}{4}$ inch below and $\frac{3}{4}$ inch above,[*] and it must be taken from a part entirely in front of any cicatricial tissue.

If possible, its apex should correspond to an edentulous gap in the alveolar process. If the dental artery bleed freely, a heated wire must be applied, or the triangular gap plugged with strips of aseptic gauze.

Owing to the tendency to relapse,[†] passive and active movement should be made use of early, and, at first, if needful, with the aid of an anæsthetic.

Dr. Maas[‡] relates the following case:—A man, aged twenty-seven, suffered from immobility of the jaw, dating to scarlatina at the age of seven. Secondary dentition had been attended with great difficulty in the removal of the first teeth, the permanent ones being irregularly developed, and mostly displaced laterally. There was not the least movement under anæsthesia. Esmarch's operation performed on both sides produced movement with voluntary painless opening of the mouth amounting to 1¼ inch.

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[*] In two of Mr. Heath's cases the wedge removed included the mental foramen.

[†] This relapse is more likely if the wedge is not removed well in front of all cicatrices. Thus, Mr. Heath (*Dis. and Inj. of the Jaws*, p. 332) found, two years after Esmarch's operation for complete closure of the jaws, that the interval between the left molars had diminished from $\frac{7}{8}$ to $\frac{1}{8}$ inch, and that between the lateral incisors from $\frac{5}{8}$ to $\frac{2}{8}$ inch. Mr. Heath thought that in this case he had not been sufficiently careful to make the bone section entirely in front of the cicatrices.

[‡] *Arch. f. Klin. Chir.*, Bd. xiii. Heft 3.

The above shows the importance of operating early in cases where severe ulceration is certain to lead to increasing fixity of the jaw, ultimately needing operative interference.

Mr. Heath* thus states his opinion of Esmarch's operation :—It is "a comparatively easy proceeding; and in cases where only *one* side of the jaw is affected, restores the patient a very useful, though one-sided, amount of masticatory power in two or three weeks, and with very little suffering or annoyance. One side of the jaw is, however, rendered permanently useless (its previous condition), and there is a necessarily resulting deformity, which is not, however, of a very distressing character. The paralysis, from the division of the nerve, is so slight as not to be worthy of mention."

Suturing of Displaced Inter-articular Fibro-cartilage.—Where sub-luxation of the cartilage does not yield, as it usually will, to blistering, tonics, &c., and troublesome clicking and catching of the jaw persist, Prof. Annandale has twice successfully operated as follows (*Lancet*, 1887, vol. i. p. 411):—An incision about ¾ inch long is made over the posterior margin of the external lateral ligament, and carried down to the capsule. Bleeding being stopped, the capsule is opened, and the fibro-cartilage seized and drawn into position, and secured by catgut to the periosteum and other tissues at the outer margin of the joint.

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* *Loc. supra cit.*, p. 338.

CHAPTER VIII.

OPERATIONS ON THE LIPS.

HARE-LIP AND OTHER PLASTIC OPERATIONS ON THE LIPS.

HARE-LIP (Figs. 69–79).

Best Time for Operation.—Any time after the second or third month. For most cases the third to the sixth month is the best. All should be over by the seventh month, when dentition begins.

With regard to operations at an earlier or later date than the above, it is interesting to note what Sir W. Fergusson, whose experience was unrivalled, advocated with a riper experience. Thus, in his *Practical Surgery* (4th ed. p. 573, 1857), he writes, "I have myself operated very frequently within the first three weeks;" and a little later, "From all my reflections and experience on the question, I am more than ever disposed to recommend a very early operation." In his *Royal College of Surgeons Lectures on the Progress of Anatomy and Surgery* (1867), with an experience of between 300 and 400 cases, he writes, "I decidedly prefer about the end of the first month." Writing later on (*Brit. Med. Journ.*, 1874, vol. i. p. 403), Sir William stated that his favourite time was from "three weeks to three months."

While the rule of British surgery is to get the operation over before dentition, many German surgeons defer taking any steps till the child has entered on the second year. Thus, Prof. Billroth* announces his practice as follows :—"Unless the parents urgently demand an operation as early as possible, I generally prefer to operate on children when they are more than one year old. I always advise this in strong children with complicated hare-lips, especially when the inter-maxillary bones are displaced and the hare-lip is double. I have been particularly satisfied with the results of operation, as far as appearance is concerned, on children at rather later periods of life and in adults." Some further remarks of Prof. Billroth are quoted at p. 343.

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* *Clin. Surg.*, *Syd. Soc. Trans.*, p. 78.

My reasons for deferring the operation, as a rule, till after the third month, are—

1. The difficulties of getting children with hare-lip to take sufficient food are exaggerated. Very often, unless the palate is cleft in addition, these children can suck well, and are in good condition. When the palate is also cleft, a serious difficulty may arise from the food passing into the nose, but this may be usually met by careful feeding with a small spoon put well back, if a sucking-bottle with a large teat and a good-sized hole in it fails (p. 347). This it will very rarely do, if slowly raised so as to give a little milk each time. Sometimes it is best to have the child raised when fed. The mother's milk should always be drawn and given when possible.

Where the child really cannot get sufficient nourishment, and is marasmic from this cause only, the surgeon may of course operate before three, or even two, months. But a child that is daily wasting is, daily, less and less able to meet the strain entailed by the operation, and consequent repair. This should be clearly understood by the friends, and also the following fact:—

2. It is not uncommon for children with hare-lip to die soon after birth from causes quite apart from this deformity—viz., diarrhœa, lung-trouble, exhaustion. In other words, in large towns many children with hare-lip suffer also from atrophy and wasting. In such, operation is unadvisable. It will not mend matters, and death will be put down to it, and not to the above causes, which would have destroyed the child in any case. In another, smaller, class of cases the operation itself, chiefly from the pain it causes in a weakly child, seems to start a process of fatal wasting.

3. As stated by Mr. T. Smith,* "the operation can be done much more perfectly and artistically on a young child than on a new-born infant, the parts being larger, more fleshy, and more easily handled." Sutures also cut out less readily.

4. For the first few weeks of life the child has scarcely got over the change from intra-uterine to extra-uterine life, the digestion is not yet, so to speak, in full swing, and a very slight shock may be too much for the low vitality of this period.

Condition of the Hare-lip.—Before operation, the following must be inquired into. Is the cleft single or double? If single, is it simple, *i.e.*, without involving the nose, and without fissure of the palate? Are the sides equal and acute-angled, or divergent and unequal? Other sources of difficulty are, much flattening of the nose from the septum being adherent and dragged over to the superior maxilla on one side, and the ala of the opposite side being spread out and stretched over the upper part of the fissure. Or the edges of the lip are widely apart, and by no means to be approximated, the alæ being so widely separated that lines let fall vertically through them only just come within the angles of the mouth.

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* *Lancet*, 1867, vol. ii. p. 761.

Other more general points will of course be remembered as influencing the result of the operation. Amongst these are, the digestive and sleeping power of the infant; its family history; the existence of any weakening condition, such as otorrhœa; and, by no means least, the good sense and patience of the nurse.

The **Single Hare-lip** operation and the one applicable to the largest number of cases will be first described fully, and then one or two modifications.

(i.) **The Usual Operation** (Fig. 69).—The child being wrapped in a long towel, mummy-wise, to ensure the hands being secured if it "come to" prematurely, ether or chloroform is given, and the head is held suitably presented to the operator by an assistant, whose hands, at the same time, make pressure upon the facial arteries as they cross the jaw. The lips, and, if needful, the alæ also, are now freely separated from the subjacent bones to allow of their coming together without tension; during this step the knife should be kept very close to the bone, otherwise the hæmorrhage will be free. Sometimes, to enable the lip to glide downwards without tension, it is necessary, in addition to separating the soft parts as above, to carry the knife round the alæ nasi and upwards in the furrow between the nose and the cheek. Sutures will not be needed in this wound, as the parts fall readily together.

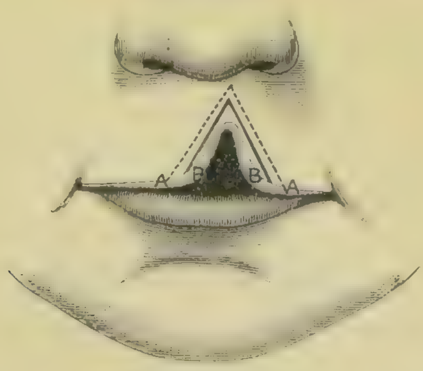
If one maxillary bone project inconveniently beyond its fellow, it must now be forcibly bent back with non-serrated forceps covered with thin drainage-tube or wash-leather. The bone should be felt to crack when this is done; otherwise, if merely bent back, it springs forward again and causes tension on the flaps.

If necessary, the anterior plate of the bone must be divided with strong scissors or a very fine saw. Whichever is used, care should be taken to apply it above the level of the tooth-sacs.

Dr. Rawdon (*Brit. Med. Journ.*, 1883, vol. ii. p. 724) advises that this bone should never be interfered with if the two halves of the lip can be brought together over the projection without tension, as (1) the curing of the hare-lip is sufficient to diminish the gap and depress the projection, and as (2) by interfering with it a low condition of septicæmia may be set up.

The edges of the cleft are now pared. This, the most important part of the whole operation, must be done carefully and thoroughly as well. The surgeon seizes the lower angle of each flap, alternately, either with his left forefinger and thumb, or, if the parts are very small and slippery, with tenaculum-forceps which should not hold the soft parts too near the edge, or it will tear out too soon. The edges being thus made tense, the surgeon with a narrow-bladed, small knife pares them as widely as possible by two incisions beginning above at the upper angle of the cleft, curving outwards somewhat as they descend, quite clear of the edges of the fissure, and then, in the lower part, curving inwards again through the red prolabium. Beginners nearly always make the mistake (Fig. 69) of removing only a thin paring of red surface. The pared surfaces should be made as wide as possible, especially below, in order that the sutures may hold better and the lip be deeper. If one margin of the flap is longer than the other this should be pared first, and after this its fellow, that both may correspond. During this paring, hæmorrhage must be prevented either by the assistant who compresses the facial while he supports the head, or by an assistant compressing the coronary

Fig. 69.



(After Whitson.*)

The dotted line shows the cleft widely and freely pared. The dark one shows timid paring close to the prolabium. The advantages of the first incision are—(1) A broader lip. (2) Firmer union, as a greater number of vascular points are cut which will throw loops across. (3) A better grasp for the sutures. (4) A more vertical depth to the lip, the two points, A, A, being on a lower level than B, B. On the other hand, if dotted lines are followed, a triangular notch must ultimately ensue, owing to the marked slope which prevails along the prolabial edges from B to A.

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* *Edin. Med. Journ.*, 1883, p. 7.

artery, between his finger and thumb, at the corner of the mouth, or by hare-lip clamps placed at the corners of the mouth.

The assistant who steadies the head and keeps pressure on the facial arteries, now, with two fingers, presses the cheeks together, so as to bring the flaps into apposition while the surgeon introduces his sutures. I much prefer for these, first, one of medium silver wire to command the coronary arteries, and passed close to the mucous membrane. If one flap is still shorter than the other, this stitch may be passed through the opposite side from below upwards, then entered on the shorter side at a point a little higher than that at which is left its fellow and passed from above downwards so as to tilt down the margin which is highest and bring it level with the other. This first stitch being passed, and the chief fear of bleeding removed, three or four others of fishing-gut, horsehair, or fine carbolized silk are inserted, one being placed in the free margin of the lip to keep the wound carefully closed here against the entrance of milk, saliva, &c. In adjusting the top stitch care must be taken that it does not too much depress the tip of the nose, if the cleft has been one running up into the nostril. All the chief stitches should be inserted with very fine needles, $\frac{1}{3}$ inch from either side of the cleft.

It will be gathered from the above that I do not advise the use of hare-lip pins. They are useful no doubt in promoting close and accurate union where the parts come together easily, but at the expense of the risk of sloughing and scars even here; where tension is considerable this risk is very much increased. The surgeon will, I think, do more wisely who adopts the sutures already described, preventing tension by freely separating the soft parts from the bone. If pins are used they should be far slenderer than those usually sold, the first should be inserted low down so as to command the coronary arteries, and if one side of the cleft is shorter than its fellow the pin should be passed, so as to draw it down, in the manner already described.

The sutures being tied, the nostrils are cleared of any clots, some iodoform is dusted over the wound, collodion* is painted on evenly, a tiny bit of lint smeared with eucalyptus ointment or some aseptic wool is placed over the wound, and one or two pieces of waterproof or Leslie's holland-strapping, cut narrow in the centre, are applied.

We still want some instrument for the after-treatment of hare-lip, adaptable in hospital practice to different-sized heads. Hainsby's truss, ingenious as it is, has serious drawbacks. As it is only adjustable to that head for which it was made, the surgeon needs several sizes. It should always be worn for several days before the operation, not so much to approximate parts as to prevent pressure-sores, which form extremely easily and leave disfiguring scars.

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* The collodion will not only help to hold the parts together, but will prevent milk, saliva, &c., from getting between the flaps.

In the after-treatment, the wound may be looked at on the second or third day, the silver wire removed on the fourth day, and the others left in much longer. A camel's-hair brush is the best way of cleansing the wound. On each occasion the cheeks must be most carefully supported.

One point of great importance is not alluded to in surgical works, and that is, that in some cases of hare-lip death from dyspnœa may take place very soon after the operation. Thus, where the cleft has been a large one, and the upper lip when restored is tight, when it overhangs the lower, if the nostrils are flattened and partially closed by the operation, owing to the tension of the parts, so little breathing space may be left that temporary interference with respiration may occur with grave and even fatal results before the breathing can be accommodated to the altered circumstances, and before the parts dilate and stretch.

The first case that drew my attention to this accident occurred in the early part of 1887 at Guy's Hospital. I had operated on an infant, aged three months, with a large cleft with unequal sides, and going through the alveolar margin, the two halves of these being on different levels. The projecting alveolus was broken back into position, pared, and stitched with chromic catgut to its fellow. The edges of the cleft were then pared and united. They came together excellently, the wide cleft being replaced by a deep upper lip. One nostril was rather chink-like. About half an hour after, whilst I was engaged in another operation, a message came that the child was livid and dying. I had the child at once brought to me in the theatre, the strapping was removed, the tongue carefully drawn forward, and artificial respiration performed. The child quickly came to and began to cry, though not very vigorously. Three-quarters of an hour later its breathing again failed, and, though Mr. Wacher, the senior house-surgeon, at once repeated the artificial respiration, we were unable to resuscitate the child. At the post-mortem examination no clot was found in the fauces, nor anything else wrong.

I find that my old friend G. A. Wright,* of Manchester, has recorded two such cases. The children here were aged three and five weeks respectively, the hare-lips double; in one, after the operation, the lower lip was drawn in so much as to leave but a small opening, but there was not apparently any dyspnœa. In one case dyspnœa came on suddenly, and, as no relief followed on pulling the tongue out, tracheotomy and artificial respiration were performed. The child came round, but a few hours later the breathing failed again, and the child died. In the second case, the child was found dead in the night. "The cause of death was probably valve-action of the lower lip."

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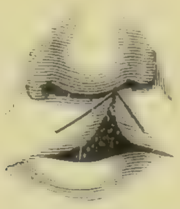
* *Abstracts of Cases Treated at the Pendlebury Hospital*, 1885, p. 146. In his

In cases of hare-lip where the divergence is great, and where the sides of the cleft are very unequal, the following operations may be made use of, but it will be found that, on the whole, the first-mentioned is not only the quickest performed, but also gives the best results whenever, by free separation from the jaws and broad paring of the edges, the flaps can be adjusted together.

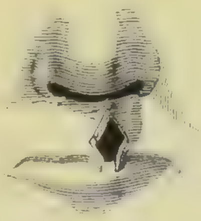
(ii.) **Operation of Clémot* or Malgaigne** (Figs. 70, 71).—The edges are pared down to, but not beyond, the red lines, the flaps thus detached above are turned downwards and kept out of the cleft with a probe. The upper part of the cleft is then sewn together with the sutures already advised, while the projecting tongue is shortened as required with a pair of sharp scissors and united with one or two points of horsehair. The chief objection to this method is, that, unless great care is taken, a little skin, imperceptible at first, but showing white after a time, may remain below the red line, or as a break in it. Again, the projection is very liable to get in the way during feeding.

FIG. 70.



(Nélaton.)

FIG. 71.



(Nélaton.)

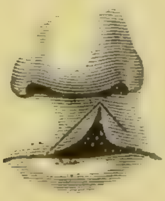
Where the divergence is more marked, and the sides of the cleft very unequal, the following may be made use of.

Abstracts for 1883 Mr. Wright records a case in which, after operation for hare-lip, there was so much dyspnœa, from the tongue clinging to the roof of the mouth at each inspiration, "that it had to be pulled out and fastened by a ligature."

* M. Nélaton (*Pathol. Chirurg.*, t. iv. p. 496) states that M. Malgaigne here imitated M. Clémot of Rochfo

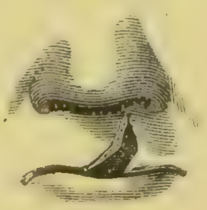
(iii.) **Method of Mirault** (Figs. 72, 73).—On the side which is the most vertical of the two an incision is to be made downwards and outwards from the apex of the cleft to the junction of skin and mucous membrane, so as to leave a flap on this side free above, but attached below. The other more sloping side is then freely pared throughout its extent from the apex downwards and outwards. Any adhesions of the lips to the gums being then thoroughly separated, the flap is brought across and attached to the pared opposite side with the sutures already mentioned.

FIG. 72.*



(Nélaton.)

FIG. 73.

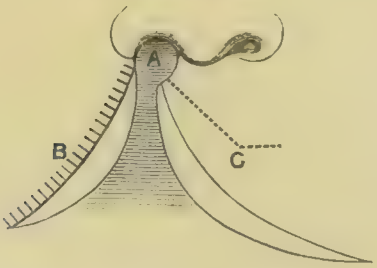


(Nélaton.)

If this method be made use of, the flap must not be a mere paring, but cut as thick and succulent as possible, and the opposite side must be thoroughly and widely refreshed.

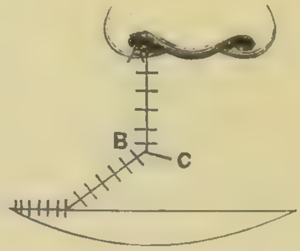
Figs. 74 and 75 show a modification of the above introduced by Mr. Owen,[†] which I have found useful. The right lip is first widely pared. To free the flap which is to be brought across from the left side, the incision is first made as usual from A to C, and then outwards. The object of this outward prolongation is to enable the flap to lie level smoothly when it is brought over—*i.e.*, without kinking, to which there is otherwise a tendency.

FIG. 74.



(Owen.)

FIG. 75.



(Owen.)

(iv.) **Method of Nélaton** (Figs. 76, 77).—This gives another means of substituting a protuberance for the cleft. An incision resembling a V reversed is made around the upper angle of the cleft. By this means the red edge of the cleft is separated from

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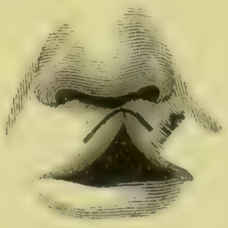
[*] The sides, especially the one which is refreshed throughout its whole extent, should be pared as in Fig. 73—that is, somewhat angularly—so as to promote the adjustment of the flaps, as it were by interlocking

[†] *Lancet*, 1887, vol. ii. p. 361.

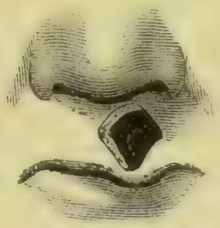
the two halves of the lip, except at each corner below. This red edge is next turned downwards, or reversed so that the Λ-shaped wound becomes diamond-shaped. The bleeding surfaces are then brought together by the means already given.

FIG. 76.



(Nélaton.)

FIG. 77.



(Nélaton.)

Mr. Holmes (*loc. infra cit.*) considers that Nélaton's operation is peculiarly adapted to clefts which do not extend through the whole depth of the lip, but terminate at some distance from the nostril. These instances are rare, but Mr. Holmes further points out that in cases where an unsightly notch is left behind, if there be not much cicatrization around the incision, the deformity may be almost certainly remedied by this operation.

DOUBLE HARE-LIP (Figs. 78, 79).

This is often easier of cure than single hare-lip with very divergent sides and the alveolar margin cleft and its two parts on unequal levels. For in double hare-lip the mischief is often symmetrical, and the sides less divergent.

Mr. T. Smith (*loc. supra cit.*, p. 799) gives the three following varieties of hare-lip which are met with here and which are of practical importance :—

(α) When the pre-maxillary bone is *in situ*, and the two clefts are simple and fairly bilateral.

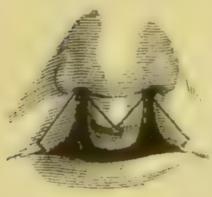
(β) When the pre-maxillary bone is separated from the rest of the jaw and projects forwards, in some cases slightly, in others being attached to the vomer and hanging from the tip of the nose.

(γ) When the pre-maxillary bone is small and ill-developed, and when the clefts are widely gaping.

The first two of these require notice.

(α) If the pre-maxillary bone is in proper position, the skin over it is freed from its attachments behind and pared to a point. The sides of the cleft are next pared from above downwards (as in Fig. 78), and the parts brought together by transfixing the sides and the central flap with a silver wire suture, every care being taken to keep the central piece well down. Horsehair and gut sutures are also used as well. As the central piece is always shorter than the lip itself, the resulting wound is Y-shaped, and it is the side flaps which meet each other in the middle line below. Care must be taken to free the central flap right up to the nose, and not to depress it too much with the sutures, otherwise the nose will be flattened.

FIG. 78.

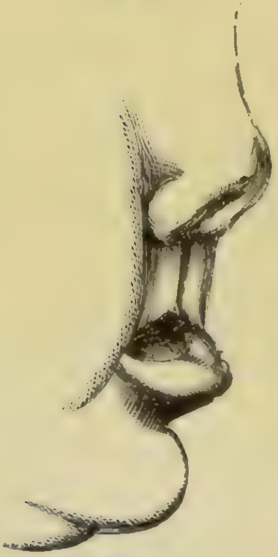


(Nélaton.)

(β) Cases in which the pre-maxillary bone is separated from the maxillæ, projecting forwards, sometimes being even attached to the very tip of the nose.

The question of removing or leaving the pre-maxillary bone arises here, and the very best authorities have differed widely. Many have advised its removal, if it projected much, because (1) pressing it back is difficult and unsatisfactory; (2) if it be pressed back, it rarely unites by bone; (3) in such a case it will act as a wedge, preventing closure of the alveolar arch and palate-fissure; (4) the teeth in it (the central incisors) cannot be relied upon to come through usefully; and (5) a dentist can fit a plate that will answer the purpose quite as well. On the other side, Mr. Holmes* argues thus: "It is of the highest importance to preserve, if possible, this portion of bone, for these reasons: (1) If the bone be removed, there must be a permanent gap through the hard palate. (2) There must also be a flattening and malposition of the upper lip, in consequence of its having lost its bony support; and from this flattening of the upper jaw it will result that the lip will be very short and tense, and the patient extremely 'underhung,' a very unpleasing deformity" (Fig. 79). To this I would add two more—that (3) the presence of this bone is needful for the preservation of the due width and arch of the bone, and (4) that such an arch will best carry artificial teeth, if any are needed owing to the unsatisfactory eruption of the natural ones. Thus most surgeons will prefer to follow Mr. Holmes' advice. Mr. Holmes, a little later, goes on to say that in a few cases it may be necessary to sacrifice the bone—*e.g.*, where it is very far forward, very much out of proportion to the neighbouring parts, and the child very weak.

FIG. 79.



(Holmes.)

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* *Surg. Dis. of Children*, p. 108.

I am of opinion that, if the following points be attended to, the pre-maxillary bone, however advanced and firmly based, can be replaced and preserved; weakness on the part of the child, which is undoubtedly a matter of grave consideration in cases like this, where the loss of blood is considerable, is best met by doing the operation by two stages—in other words, being content to first get this bone replaced, and leaving the uniting of the soft parts till another time.

Where the stalk of attachment of the pre-maxillary bone is slender, and where there is plenty of room between the two maxillæ, it may be often broken back into place by the operator supporting with his left hand the back of the child's head and then with his right thumb sharply fracturing back the bone. This should be done thoroughly, and, if needful, by the aid of non-serrated forceps covered with drainage-tube, or bone-forceps may be applied to the stalk in front and also behind till it is almost completely cut through. If now it can be replaced, but tends to come forward again, it should be sutured, on one side at least, to the maxillæ with chromic catgut or carbolized silk, or wire.

If the maxillary bones on one side or both are in the way, and prevent the replacing of the pre-maxillary bone after it has been detached sufficiently, or if this is too voluminous, its sides must be cut away and the maxillæ also pared till the central piece can be pushed back between them and retained with a suture, as above advised.

A severer method, one, therefore, which should only be tried when all other means of replacing the pre-maxillary bone have failed, is to cut a wedge-shaped gap out of the septum nasi and to press or fracture the partially detached bone into the gap. Some have passed a suture* through the septum before the wedge is cut out, and then united the ends over the pre-maxillary bone to keep it in place.

The hæmorrhage may be very free in these cases where very vascular bones are cut through. I have generally found that it is at once arrested by suturing the bones, but in some cases it may be needful to apply a fine point of actual cautery or of the thermo-cautère; if this has been necessary, or if the child is very weakly, the uniting of the soft parts had better be left to another time.

It is absolutely necessary, by some means or other, to get the pre-maxillary bone quite back and to make it stay there, as otherwise the soft parts over the projecting bone, or the line of union which often comes just opposite to it, will be pressed upon and give way.

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* If he do this the surgeon must be provided with needles of different curves. Small curved ones in a holder offer more variety than those in handles.

So where the surgeon is unable to get the bone back by any method, he may follow the advice of Sir W. Fergusson,* and incising the mucous membrane over the bone, separate this sufficiently to introduce a small gouge about ¼ inch broad, scoop out the temporary incisors, and cut away the wall of bone, which for the first eight weeks consists of merely a few plates. By this the projection is removed, and the tissues which remain offer no obstruction to the union of the lip in front. Only the mucous membrane and some periosteum are left to form a soft cushion behind the united lip.† Furthermore, by this means any spirt of blood is avoided.

Causes of Failure and Death after Hare-lip Operations.—Amongst the commonest of these are—(1) Feeble vitality. Marasmus. Many infants die after hare-lip operations, but while the effect of loss of blood and pain must not be lost sight of, in most of the fatal cases death is due, not to the operation, but to feeble vitality. Whether operated on or not, the majority of these cases would have died in infancy. (2) Hæmorrhage. This, if serious, is due either to very free separation of the flaps in a weakly child, or (a cause much less excusable) to the coronary arteries not having been properly secured. Loss of blood will lead to non-union, but it may destroy life rapidly by a clot in the fauces and upper aperture of the larynx. One case has come to my knowledge in which, after operation, this untoward result would have happened, the child getting increasingly blue and breathless, had it not been for the prompt common-sense of the nurse in charge, who fished out a large clot with a sponge on a holder. (3) Bronchitis and broncho-pneumonia. (4) Diarrhœa. (5) Asphyxia (p. 336). (6) A low septic condition, especially where the bone has been interfered with in a weakly infant, and under conditions always averse to aseptic healing.

Repetition of Operation.—I may remind my younger readers that in many cases a perfect result cannot be secured by one operation. Where parents are likely to be unreasoning and unreasonable, the surgeon should warn them of this.

In cases unfavourable, owing to the malformation, or the general condition (p. 333), hare-lips which have been operated on often cause disappointment, however much they resemble pictures in books up to the third day. Incomplete closure, below or above, a little inequality in the level of the halves of the new lip, some flattening and closure of the nostrils—any of these may mar the first operation. The more operations a surgeon does the more difficult and trying cases will he meet with. He can scarcely do better than remember the words of the great surgeon of Vienna:* "Operations on little children do not always succeed as well as could be wished, on account of the diminutive size and softness of the parts. The flaps of the lips cannot always be adapted as exactly as desired, and even if this be satisfactorily accomplished, the result does not in every case quite come up to expectation, so that, some few years after, further slight proceedings become desirable, in order to improve the appearance." And, again, a little later, the same surgeon, speaking of operations on "quite little children," says: "I decline to give any absolute guarantee with regard to the result in such cases."

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* *Brit. Med. Journ., loc. supra cit.*

† This cushion can be stitched to the maxillæ, if needful.

OTHER PLASTIC OPERATIONS ON THE LIPS

(Figs. 80–83).

These are very numerous, especially for the restoration of the lower lip after ulcerations, epitheliomatous, &c., injuries and burns. A few of the chief will be described here.

The chief objects which the surgeon must keep before him are: (1) to get sufficient flaps of healthy tissue, consisting of skin outside and mucous membrane within, and to secure as free a margin as possible of this last; (2) to keep the flaps together with as little tension as possible; (3) to cover in the teeth sufficiently, preserving the mouth-opening of appropriate size.

Lower Lip.

(i.) **Method of Serres** (Fig. 80).—Where a growth implicates the whole of the lower lip, but does not extend far down upon the chin, this operation gives excellent results. If the angles of the mouth are also involved, the operation consists practically in removing three triangular portions of soft parts, as shown in the dotted lines in Fig. 80. Two of these have their apices on the cheeks, and their bases at the angles of the mouth, while the central triangle has its apex downwards towards the chin, and its base turned upwards to the mouth.

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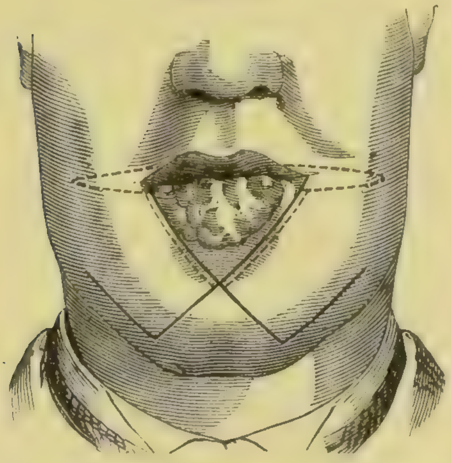
* Billroth, *Clin. Surg.*, p. 79.

If the angles are not involved, straight incisions, and not triangular ones, may be made out on to the cheeks, while, if needful, the apex of the central can be carried down on to the chin or even on to the neck, some further incisions being usually required in such a case—viz., curving outwards laterally from the apex along the jaw or in the sub-maxillary region, as in Fig. 80. The flaps are united with silver wire, salmon-gut, and horsehair; a few fine hare-lip pins being used, if needful, to overcome tension. The sutures should be put in sufficiently close to distribute any tension evenly, and the chief ones should be one-third of an inch from the edges of the wound, and should be passed close to the mucous membrane. As far as practicable, bleeding points should be commanded by sutures, and torsion or ligatures dispensed with as far as possible. Any pins used should be removed on the second or third day, and the sutures one or two at a time. Iodoform and collodion is as good an application as any.

FIG. 80.



The dotted lines show the operation of Serre, the continuous ones that of Syme. The central part of each runs too near to the growth.

(ii.) **Method of Syme** * (Fig. 80).—This operation leaves the central and prominent part of the chin undisturbed, two lateral flaps supplying the defect.

Supposing the whole lower lip affected, the growth is removed by two incisions passing from the angles of the mouth to the prominence of the chin. Bleeding-points being compressed by assistants, the surgeon makes two incisions from the apex of his first, passing at first straight downwards and outwards, and then curving outwards and upwards, so as to free two large lateral flaps, which are dissected up as thick as possible and united in the manner already described. The first part of the two lateral incisions—viz., those passing downwards and outwards—meets in the middle line to form the new lip. This is supported by the prominence of the chin, which retains its natural connections. The lower and more curved parts of the incision must be carried outwards towards the angles of the jaw in order to allow the flaps to come into position readily, and without tension, and without leaving gaps to granulate.

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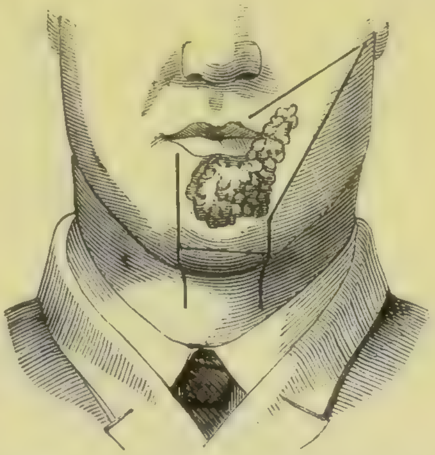
* *Observ. in Clin. Surg.*, p. 60.

(iii.) **Method of Buchanan.**—This is planned on the same lines as that of Prof. Syme. The growth is removed, here, by an elliptical incision. From the centre of this two incisions are made, first downwards and a little outwards, and then from the ends of these two curving outwards and upwards, much as in Prof. Syme's operation. When flaps thus marked out are detached and raised, the elliptical incision becomes horizontal and forms the new lower lip.

Both in this and Prof. Syme's operation, when the gap is very large or the soft parts scanty, two small triangular gaps may be left below. These will heal by granulation, promoted by skin-grafting.

(iv.) **Method of Chopart** (Fig. 81).—The growth is removed by a quadrangular incision, the upper margin being formed by the lip, the lower by an incision parallel with it across the chin, and at the sides by two vertical lines dropping down over and below the jaw. A square-shaped flap is then dissected up from below, and brought up to form the lower lip. The weak point is that, in spite of keeping the head flexed, the flap tends to sink down. This might be, in part, prevented by freeing the flap more completely by carrying out into the sub-maxillary regions lateral incisions curving outwards and upwards from the ends of the vertical ones.

FIG. 81.*



The quadrangular incisions on the chin will indicate the method of Chopart. The triangular incisions show how a growth at the corner of the mouth may be dealt with. (After Serre.)

Upper Lip.

(i.) **Operation of Sédillot by Vertical Flaps** (Fig. 82).—Flaps quadrangular in shape are raised by the following incisions:—(1) the internal one, starting from a point midway between the angle of the mouth and the lower eyelid, and ending usually at a point on a level with the prominence of the chin; (2) a horizontal one passing outwards from the lower end of the first for $\frac{1}{2}$ to 2 inches; and (3) a second vertical incision passing upwards from the outer end of the horizontal one to a point on a level with the ala of the nose.

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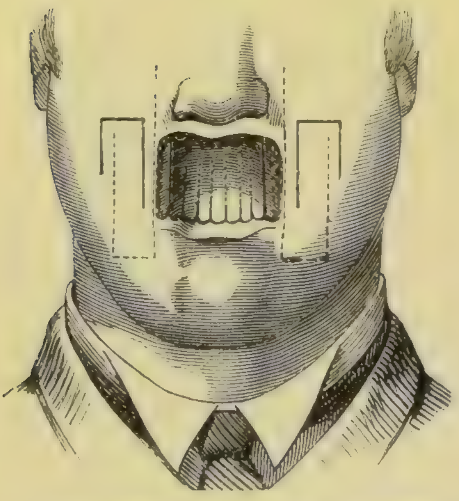
* This and the next two figures are taken from M. Serre's atlas accompanying his *Traité sur l'Art de restaurer les Difformités de la Face, selon la Méthode par Déplacement.* Montpellier: 1842.

These flaps, comprising the whole thickness of the cheeks, are moved inwards so that their lower extremities meet vertically in the middle line.

(ii.) **Operation of Dieffenbach and Chauvel by Vertical Flaps.**—Here the flaps are cut in the reverse direction to that of Sédillot. This method is to be preferred, as, owing to the base being below, there is less tendency for the new lip to be raised by the contraction of the scar, and thus to expose the upper teeth.

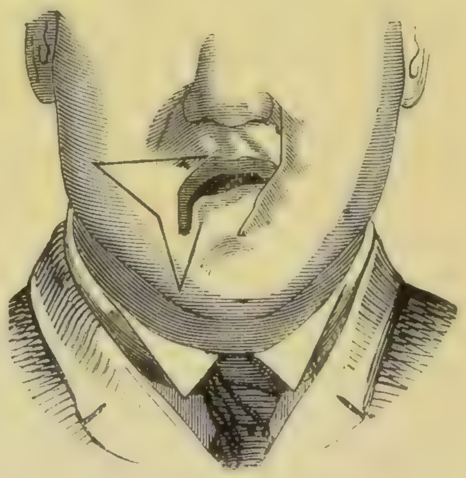
(iii.) **Operation by Lateral Flaps.**—Here the flaps are taken laterally from the cheeks. They should be cut of the full depth of the new lip, and at their outer extremities should curve downwards so as to diminish the tension.* Their inner extremities are united in the middle line below the nose.

FIG. 82.



The dotted lines show the operation of Sédillot, the continuous ones that of Dieffenbach, for making a new upper lip. (After Serre.)

FIG. 83.



(After Serre.)

(iv.) **Operation for Restoring One Angle of the Mouth.**—Fig. 83 shows the steps which would be adapted for restoring the right angle of the mouth which has been distorted by cicatricial contraction: the same proceeding being available for a growth situated here.

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* Dr. Port, of New York, who figures this operation and numerous other methods from Szymanowski (*Handb. d. Chir. Med.*, Braunschweig: 1870), lays stress upon this precaution (*Inter. Encyc. Surg.*, vol. v. p. 489).

CHAPTER IX.

OPERATIONS ON THE PALATE.

OPERATIONS FOR CLEFT PALATE—REMOVAL OF GROWTHS OF THE PALATE.

OPERATIONS FOR CLEFT PALATE (Figs. 84, 85).

Age for Operation. — If the general health be good,* the temper fairly sweet, and the cleft not a very wide one, the first attempt to close the gap may be made any time after three-and-a-half or four years.† If any further operation is required it should be performed in the fifth or sixth year, and any case, however difficult, should be completed, if possible, by the ninth or tenth year. As a rule, the healthier the child and the smaller the cleft, the earlier may the operation be tried.

Operations have no doubt been performed during the first year of life, but the risk of failure is great owing to the effects of hæmorrhage, the readiness with which convulsions are excited, the delicacy and proneness to tear of the soft parts, while, as has been pointed out by Mr. T. Smith, during the first three or four years, clefts of the bony palate generally diminish much in width.

Severity of the Case and Kind of Patient.—It is not so much the extent of the fissure—whether the soft palate is alone affected, partially or completely, whether that common form, in which the cleft involves the soft and a portion of the hard is present, or whether the whole part is split—that is of importance, as the width of the cleft and the thickness of the tissues which bound it. Sir W. Fergusson was, I believe, the first who pointed out the influence which the height of the vault of the hard palate has upon an operation for closing a cleft of it. He showed that the higher the vault the more easy was it to dissect down flaps of muco-periosteum, while, on the other hand, the less arched the vault, the greater was the difficulty in getting sufficient flap. Other points of importance are the size of the mouth, a very narrow or small one interfering with the use of the needful instruments ; and finally, a point always to be noted, the length of the palate, for the shorter this is, the more impossible will it be for this to touch the pharynx later on, however perfectly it has been united, and the more marked, consequently, will be the nasal tone of the voice.

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* The difficulty of feeding these cases is often put forward by the friends as a reason for an early operation. Cases are extremely rare in which sufficient food cannot be given by one of the following methods (especially after any co-existing hare-lip has been closed), if only sufficient pains are persevered with—viz., a small spoon passed well back into the mouth ; a feeding-bottle with a teat big enough to fill the gap, the teat being perforated underneath for the escape of the milk, only a little being given at a time ; an ordinary feeding-bottle, with a leaf-like piece of india-rubber attached above the teat, so as to fill up the gap (as advised by Mr. Coles) ; finally, sometimes deglutition will be facilitated if the nurse closes the nostrils with her finger and thumb every time the child swallows, or feeds the child well propped up.

† When Mr. Davies-Colley's flap method is used, the operation may be performed earlier (p. 353).

Other points of importance, but not connected especially with the cleft, are, some which bear upon the general health of the patient—viz., fretfulness or a sunny temper, greediness, as likely to cause bolting of surreptitious food, co-existing ear disease, or congenital syphilis ; whether the child has had the usual illnesses and exanthemata ; an attack of whooping cough, scarlet fever, mumps, or measles interfering much with the result of an operation.

Amount to be closed at one Sitting, and Order of Operation.—Where the cleft involves both palates, that through the soft is usually taken first, the severer operation being left till later. As to the amount which should be attempted at the first sitting, each case must be decided by itself, according to the experience of the operator, the severity of the case, and the safety with which the anæsthetic is taken. Mr. T. Smith, the highest authority we have on this subject, recommends * that the whole cleft should be closed at one sitting, " unless there are circumstances of peculiar difficulty in the case. When the bringing together of the whole cleft in one operation would necessitate so free a division of the soft parts as to endanger the vitality of the flaps, it is advisable to close first that part of the cleft that can be most easily approximated, whether it be the hard or the soft palate."

Had it not been for this opinion of Mr. Smith's, I should have unhesitatingly advised the surgeon in his earlier operations only to attempt to close those parts which come readily together. Any more that can be closed will only be so at the expense of a good deal of tension, and after much difficulty and a varying degree of bruising, &c.

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* *Dict. of Surg.*: art. "Cleft Palate."

Operation on the Soft Palate.—The instruments which would be required for closing a complete cleft of the palate may be enumerated here once for all. One sharp and one blunt-pointed knife (like a large tenotomy knife on a long handle), one pair of dissecting-forceps, and one with fine tenaculum or mouse-tooth ends, at least four rectangular needles with eyes at the point, or, better, a supply of small needles of different curves, to be used with a holder, a stout aneurism needle, four raspatories of varying curve and strength, a pair of curved scissors (with a $\frac{1}{4}$ inch curve) for detaching the soft palate from the hard, one of Mr. Smith's gags, which has previously been found to fit the patient, and sponge holders. In addition to the above, a tubular needle with a reel for passing wire, a wire twister, and a rectangular knife, if it be found needful to take a flap from the septum, will be found useful.

The patient's stomach being just empty, so that he shall not vomit during the operation, nor want food immediately after, he is placed on a suitable narrow table, and in a good light. As soon as he is under the anæsthetic (A. C. E. or chloroform), his hands are tied to the bandage which secures him to the table, or wrapped in a jack-towel, one being always left within reach of the chloroformist. Then either the head and shoulders are suitably propped up with firm pillows, or, as I much prefer, the head is dropped at a right angle to the spine, over the end of the table, where it is supported by a sitting assistant. This method, which I believe we owe to Prof. Annandale,* has the great advantages of giving thorough exposure of the parts now well under the surgeon's control, and of allowing the blood to collect in the upper naso-pharynx. Mr. Smith's gag is then introduced, the tongue tucked under the central plate and the jaws widely opened. The gag, which is never to be tied, is then held by an assistant who, at the same time, supports the head, and moves it to suit the operator. Another assistant hands instruments and gives other help, while sponges are wrung out and supplied on holders by a nurse.

The edges of the cleft are first pared in one of two ways—viz., by holding in the tenaculum-forceps the tip of one-half of the uvula, and thus making the soft palate tense, and then paring from behind forwards; the opposite half is then seized, and that side pared from before backwards; or, if it is preferred, the surgeon may, after making tense the soft palate, transfix the centre of each cleft alternately with a double-edged tenotome, and cut first up and then down. In either case the whole of each side should be made raw, and with as wide a surface as possible; it is the anterior angle and the tip of the uvula which are liable to remain unrefreshed. As far as possible this should be the only occasion on which the flaps are touched with the forceps.

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* *Lancet*, 1879, vol. ii. p. 685.

The sutures may be made of wire (without kinks), carbolized silk, salmon-gut, and horsehair. Of these Mr. Smith prefers wire for the hard palate and for any part of the soft in front of the uvula, preferring horsehair for the uvula itself.

If the flaps are thick and abundant, if they fall easily together, the material is, I think, of less importance. Each surgeon will, in difficult cases, find advantage from being used to certain sutures. If the surgeon has tubular needles, and if both sides of the cleft can be spanned at once, he will find it very easy to work with silver wire. Salmon-gut and horsehair seem to me to be the least irritating next to wire, and very easy to work with after being softened for ten minutes in a hot solution of carbolic acid. But if the cleft is a wide one, and if Aveling's method is preferred, it is difficult to obtain the last two forms of suture in sufficient length, and carbolized silk should be fallen back upon.

The following methods will be found useful according to the width of the cleft, and the needles used: (1) If a tubular needle is at hand, silver wire can be passed with great facility, if the cleft be a narrow one, save in the case of the uvula, for which horsehair should be used. If the cleft be a wide one, the sutures may be passed in one of the following ways:—(2) A slightly curved needle in a handle is passed through the edge on one side into the cleft, it is then threaded with wire and withdrawn, the wire is disengaged, the needle passed similarly through the other side and threaded with the end already passed; this is then drawn through the second side by removing the needle, the wire being thus brought across the gap. I owe my knowledge of this, Mr. Hardie's very simple method, to an old friend, G. A. Wright. (3) Aveling's: a double loop of suture—this is much more easily done with silk—is passed on one side and the loop drawn out of the mouth and held by an assistant; a single suture is then passed through the other side at a point opposite to this, and the end also drawn out of the mouth; this single suture is then looped into the double one, and by pulling this latter back the single one is drawn across the cleft. (4) Here they are passed much as in uniting an ovariotomy wound. A small curved needle is threaded at each end of a suture, and one is first passed in a needle-holder from right to left and the other from left to right. An assistant holds one needle while the surgeon is using the other. The second method is the easiest of all, and as efficient as any.

After the first suture is passed through the halves of the uvula, it should be used to make the edges tense, thus doing away with any need of the forceps. Attention should be paid to inserting the sutures at a sufficient distance from the edge and a due distance from each other so as to duly distribute amongst themselves any tension that may be present. In passing any suture, the needle point should be quickly stabbed through at the intended spot. When sufficient sutures have been passed, two or three should be tied (the wire being twisted with the fingers, with a twister, or torsion-forceps), the gut and horsehair requiring a third knot. Then if there is too much tension on the rest, longitudinal incisions may be made on each side of, and parallel to, the cleft. The length of these relieving incisions must vary; they usually begin on a level with the highest stitch in the soft palate and run backwards about midway between the teeth and the cleft, care being taken not to prolong them so far back as the posterior edge of the palate, or dangerously near the posterior pterygo-palatine canal (p. 356).

The amount of relief which the above incisions give, even if freely prolonged, is often disappointing, and they should always be dispensed with if possible. If there is much tension the surgeon will, I think, usually do best by not attempting too much.

Throughout the operation hæmorrhage must be arrested by sponge-pressure, and as little wiping as possible should be done, otherwise the secretion of viscid mucus is much increased. The surgeon will from time to time have to suspend his operation, to allow of additional anæsthetic being given, or for vomiting, when the head must be quickly turned on one side.

The after-treatment and the causes of failure are given a little later, at pp. 354, 356.

Operation on the Hard Palate.—The edges of this being pared, an incision is made down to the bone with a small stout scalpel about midway between the cleft and the teeth, or rather nearer the latter, and reaching from the anterior edge of the cleft to the posterior edge of the hard palate. Through this incision raspatories of suitable length and curve are introduced next to the bone and pushed inwards till their points appear in the cleft. By to-and-fro movements the mucous membrane and periosteum are separated from the bone, every possible care being taken to raise these of even thickness and without laceration or buttonholing. The chief difficulty will be met with at the two ends of the bony clefts. If the anterior extremity of the gap reaches as far as a point just behind the incisors much difficulty will be met with in separating the muco-periosteum here, and the surgeon will do well to be provided with two or three small raspatories of different curves.* Again, at the junction of the hard and soft palates, the soft parts are firmly bound down to the former by fibrous tissue. To free them a pair of angular scissors should be used, one blade being placed under the muco-periosteum, between it and the bone, and the other passed through the cleft, above the soft palate, the fibrous tissue being thus divided close to the bony palate.

While the soft parts are thus separated the hæmorrhage will be free, but always yields to pressure, either with sponge or with a finger.

When all bleeding has stopped, the sutures are inserted as before, wire or salmon-gut being used here.

Tension may in part be removed by prolonging the lateral incisions backwards.

Mr. T. Smith points out that in bringing together the halves of the palate care must be taken to evert the edges of the cleft with a small double hook in passing and twisting up the sutures.

Sir W. Fergusson's Method† (Figs. 84, 85).—This surgeon, finding that even in his hands attempts to completely close the hard palate often failed owing to the contraction of granulations, by which the lateral flaps were drawn back to their original position, introduced the following modification, which he especially recommended for apertures in the hard palate, but which he had used with great success in a complete cleft of both.

Sir W. Fergusson, having pared the edges, divided the palate, both soft tissues, and bone, first with a scalpel and then with a chisel,‡ about ¼ inch from the margin of the gap on each side. With the chisel pushed up into the nose through each incision, by slight movements from side to side, each lateral portion is prised towards each other until they meet in the middle line, when sutures are inserted between the pared edges of the soft parts. In some cases sutures were inserted not merely into these edges, but were passed through the lateral apertures right across the gap.* Hæmorrhage is arrested by plugging the lateral incisions, if needful. Nowadays some aseptic gauze is best used for this purpose.

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* Mr. T. Smith (*loc. supra cit.*) recommends the use of a small rectangular knife here.

† *Brit. Med. Journ.*, April 4, 1874. Sir W. Maccormac in the same journal (May 20) points out that Dieffenbach and Wutzer had first used a very similar operation.

‡ Preceded in some cases by drilling a line with a bradawl, as in Figs. 84, 85, drawn by Mr. Rose for Mr. Bryant's *Surgery*, vol. i. figs. 184, 185.

FIG. 84.

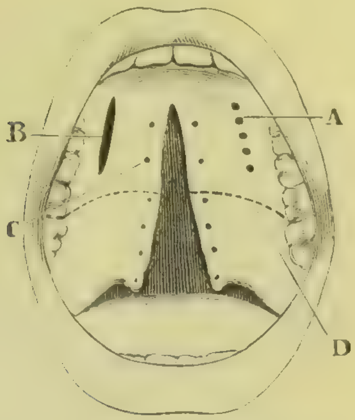
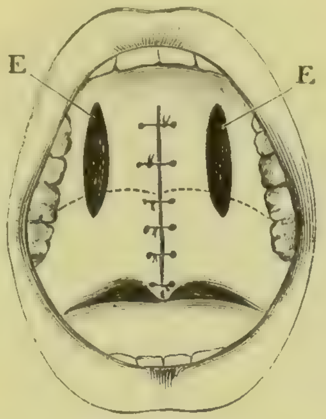


FIG. 85.



A, Preliminary punctures with bradawl to give line for chisel.
B, Incisions through bone completed by chisel.
C, Holes in hard and soft palate for sutures.
D, Junction of hard and soft palate.
E, Lateral openings subsequently filled up by granulations. (Bryant.)

Mr. Davies Colley's Flap Method for Hard Palate (Figs. 86, 87, 88).—The author of this has found that by this method he can operate earlier; thus, he has treated a child successfully at twenty months. Speech is thus likely to be much better eventually. No tissue is cut away. The knife can be used more, and thus less damage is done to the soft parts by the raspatory. Again, larger raw surfaces being left, more solid union follows. Finally, the pressure of the child's tongue against the roof of the mouth is likely to be less harmful. A flap (Fig. 86) ABC is turned up towards its base, AC, which is just behind the last molar tooth, its blood-supply from the posterior palatine artery being thus secured. A flap DE (Fig. 87) is then dissected up by a curved incision, turned over, and secured to the opposite side by two chromic catgut sutures. The raw surface of this flap is then turned downwards, looking to the floor of the mouth. ABC is then glided over to the left side, and sutured to DE. Fig. 88 shows the final arrangement when ABC is united to the opposite side, leaving in front a raw surface, where it was dissected off, while behind is exposed a little of the raw under-surface of DE.*

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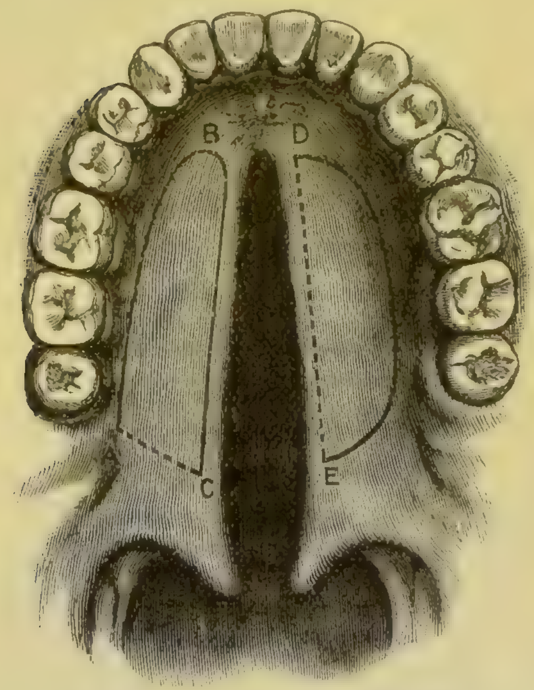
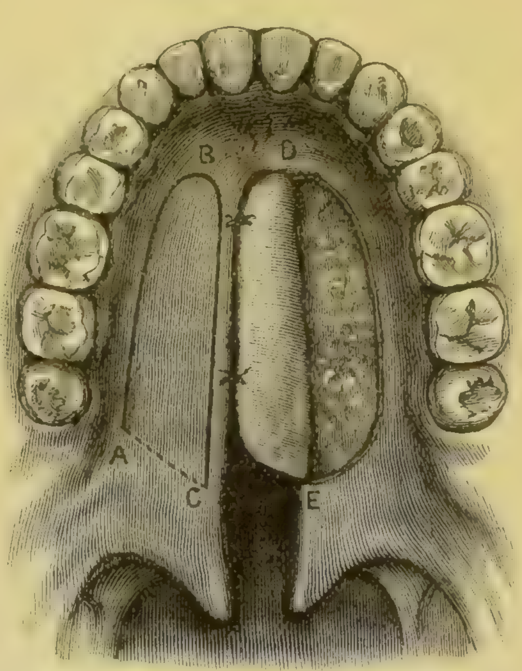
* Sir W. Maccormac (*loc. supra cit.*) shows that Dieffenbach made use of similar sutures, sometimes securing further approximation by again twisting them up later on. Sir W. Fergusson stated his belief that the objections which at first arise to his method are not valid—(1) There is no caries or necrosis; (2) there is no dangerous hæmorrhage; (3) there is less risk of sloughing than by the old method; (4) the lateral incisions heal well. He admits that if, as sometimes occurs, the vomer is found attached by its lower margin to the palate, it would be difficult to introduce stitches. But approximation alone of the edges would probably convert the gap into a mere chink, avoiding ordinary observation.

Fig. 86.



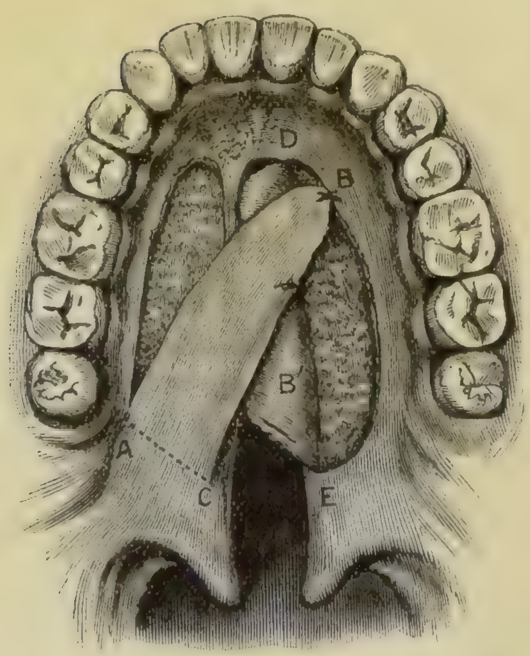
Outlines of flaps marked out.

Fig. 87.



Flap DE dissected up, turned over, and united to opposite side, with its raw surface downward.

Fig. 88.



Flap ACB glided across and united to under raw surface of DE.

After-treatment.—A small injection of morphia (gr. $\frac{1}{8}$) may be given, but no food should be allowed for three hours, only a little ice being given to suck. The hands should be secured for the first few days. For the first forty-eight hours milk only should be allowed, with a little port wine and water, nutrient enemata being given if needful. After this, yolks of eggs, arrowroot, broths, soups, and (in about ten days) light puddings, jellies, may be allowed. After the first week the patient may get up, under supervision. There should be no hurry to remove the sutures, which may remain for two or three weeks, and there should be no anxiety to look at them early and often.

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* I am indebted to Dr. Wilson Smith for these diagrams of Mr. Davies Colley's operation. They were copied at a clinical lecture. Since these sheets were printed Mr. Davies Colley has published his operation, *Brit. Med. Journ.*, Oct. 25, 1890.

To make this subject of after-treatment at all complete a few words must be said about the improvement of speech after the cleft has been surgically cured, and the occasional need of an obturator. Even after a complete closure of the cleft much awkwardness of speech is liable to remain, this being, of course, most marked the older the child is. Not only has the child to be taught the right way of using its organs of speech, but wrong habits, especially nasal and guttural tones, have to be unlearnt. This is only to be brought about by means of systematic lessons and practice gone through regularly day by day for months and even years. No plan will be found better than that recommended by Mr. W. Haward, Clin. Lect. "On Some Forms of Defective Speech" (*Lancet*, 1883, vol. i. p. 111): "The instructor should sit directly facing the pupil; the pupil is made to fix his attention thoroughly upon the face of the teacher, and to copy slowly his method of articulation. This should be displayed by the teacher in an exaggerated degree, every movement of the lips and tongue being made as obvious as possible to the pupil, and the more difficult sounds or movements prolonged for the purpose. Thus, for instance, suppose the word "sister" were to be practised, the teacher, having filled his chest with a long inspiration, would open his lips and draw back the angles of the mouth, so that the pupil could see well the position of the tongue against the teeth; he could then prolong the hissing sound of the 's,' and, finally separating the teeth as the sound of the 't' in the second syllable issues, allow the pupil again to see the position of the tongue as the word is ended. Or, for another example, take the word 'lily.' Here the teacher would separate the lips and teeth, so that the tongue would be seen curved upwards, with the tip touching the hard palate; the word would then be pronounced with a prolongation of each syllable, the teeth and lips being kept open, so that the uncurling of the tongue and its downward movement are clearly seen. So, again, in teaching the proper method of sounding such words as 'wing' or 'youth,' much aid is given by keeping the lips somewhat separated, so that the relation of the tongue and palate can be made manifest. The pupil must be made to fill his chest, and then to imitate as closely as possible every movement and sound of the teacher, and this may sometimes be assisted by making the pupil feel with the finger as well as observe with the eye the relative movement and position of the teacher's tongue and palate. There should be no other person in the room to distract the pupil's attention. It is best to continue the exercise for a short time only, and to repeat it frequently, rather than to fatigue the child by a long lesson; and it is a good plan to take an ordinary elementary spelling-book, and to mark the words which the pupil finds most difficult to pronounce, so that these may be especially practised."

With regard to the question of obturators, in cases where it has been found impossible to close a very wide cleft, or where it is evident that even after a successful operation the palate will be so tense and short as to be quite unable to touch the pharynx, and so shut off the nose from the mouth, an obturator may be required. The most useful form is probably that of Dr. Suersen, of Berlin (*Brit. Med. Journ.*, 1882, vol. ii. p. 875). The chief disadvantage is that if fitted early it will require frequent alteration; on the other hand, unless worn early it will be of little service. Just the same care in overcoming faulty habits of speaking and in teaching correct ones is required now as after a successful operation.

Causes of Failure.—1. Vomiting;* 2. Premature cutting of sutures from tension; 3. Hæmorrhage. Serious hæmorrhage in children, either at the time or later, is very rarely met with, but it is otherwise in adults.

Mr. H. Marsh,† in the case of a patient aged twenty-one, was compelled to plug the posterior palatine canal owing to severe hæmorrhage on the sixth day. The hæmorrhage recurred twice, the last being as late as the fourteenth day, and was arrested on each occasion by the following means:—"Searching with a sharp-pointed probe, passed through the lateral cut, about $\frac{1}{3}$ inch in front of the hamular process, which can be easily felt through the soft palate, and about the same distance directly inwards from the wisdom tooth, I felt, after two or three attempts, that I had fixed the probe in the orifice of the canal, and at the same time the patient screamed with pain, when the large posterior palatine nerve was touched. A wooden plug, made by sharpening a piece of firewood, was then pressed firmly into the canal, by holding it in a pair of strong forceps with its point looking upwards, and a little backwards in relation to the roof of the mouth. Directly the plug was introduced the bleeding ceased." The recurrence was due to the plug slipping out.

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* Mr. Mason (*Brit. Med. Journ.*, 1872, vol. i. p. 14) gives the case of a child, aged nine, where the vomiting of two lumbrici led to failure.

† *Clin. Soc. Trans.*, vol. xi. p. 71. On the occasion of the third hæmorrhage the patient was in a state of profound syncope. The suggestion of plugging the canal was originally made by Mr. T. Smith, in a similar case also successfully treated by Mr. Willett.

4. Whooping cough. 5. Exanthemata. 6. The child putting his finger into the wound. 7. Swallowing of solid food. 8. Feeble condition of the child, with congenital syphilis, &c.

REMOVAL OF GROWTHS OF THE PALATE.

Growths here, though rare, have a special interest, from their position, and may thus be briefly noticed. For the best account of them I would refer my readers to a very helpful paper by Mr. Stephen Paget,* in which the following points are brought out:—(1) The chief groups are the polypoid and warty, the adenomatous, the sarcomatous, and the carcinomatous; this last including the encephaloid, which are very rare, and the epitheliomatous, commencing in irritation here as elsewhere. (2) That it is hardly possible to tell beforehand to which group the growth belongs. (3) Many of them, especially the adenomata, can be shelled out with surprising ease. (4) That the growth itself should not be cut into.

In the case of large and vascular growths the aids of splitting the cheek or performing a preliminary laryngotomy and plugging the fauces (p. 384) may well be resorted to. In the case of a growth of the hard palate, clipping it away with scissors and scraping the bone will be insufficient; the bone around should be freely removed with chisel and gouge, or the palate portion of the superior maxilla removed. In a case which I saw in consultation with Dr. Wilson, of Haverfordwest, where the growth not only bulged in the palate, but in the neck as well, this excellent surgeon operated successfully by two incisions, one in the palate, and the other parallel with the large vessels at the angle of the jaw.

From what I have seen of two cases of epithelioma of the palate, starting from the alveolar process, and in one case certainly originating in an old syphilitic sore, no time should be wasted with such means as the application of acids, or the cautery, and I think that removal of the bone itself by some such operation as that of Maisonneuve (p. 313) is preferable to attacking the growth with gouge or chisel.

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* *St. Barth. Hosp. Reps.*, vol. xxii.

CHAPTER X.

REMOVAL OF THE TONGUE (Figs. 89, 90).

The day when the belief is accepted, and acted upon, that cancer of the tongue, like many other epitheliomata, has a pre-cancerous stage, and that this is the stage in which we ought to operate, will be a happy one for hundreds of patients and for the results of surgery. Of all the painful deaths by which men leave this world there are few more miserable and distressing than one which closes life by cancer of the mouth. And yet, though in the case of the tongue this most important stage is, from the position of the organ which it attacks, peculiarly under our eyes and lies open to our examination and detection, how frequently it is overlooked. I have treated of this malignancy and the other practical points above given, in detail elsewhere (*Guy's Hosp. Rep.*, 1889, p. 245).

Before describing the different operations it will be well to say something with reference to two or three very practical points which rise up with every case of tongue-cancer, a form of cancer which, it must be remembered, is very frequent and increasing in frequency;[*] which attacks all ranks of life; which, after its early stage, is especially malignant;[†] in which, finally, an operation is as much dreaded and deferred by men as one for carcinoma mammæ is by women.

A Pre-cancerous Stage.—However tongue-cancer begins, it passes through the above stage, *i.e.*, a stage (the duration of which is unknown and varies extremely) in which inflammatory changes only are present, viz., ulceration and other changes in the epithelium, not amounting, as yet, to epithelioma, but on which epithelioma inevitably supervenes. The boundary line between this pre-cancerous stage and cancer is extremely narrow; the duration of this stage may be, and often is, extremely brief.

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[*] Amongst common cancers—*e.g.*, of breast, rectum, uterus, &c.—cancer of the tongue stands about third, although so rare in women. Mr. Barker, in his carefully worked out article on "Diseases of the Tongue" (*Syst. of Surg.*, vol. ii. p. 578), gives a series of tables showing that in the last thirty years there has been a steady increase from 2.6 to 11.5 per cent.

[†] This is shown in the following facts:—(α) The rapidity here is quite different from other epitheliomata. Epithelioma, usually thought a slow cancer, here, in a moist, warm cavity, much irritated, and never dry and warty, is terribly rapid. (β) Gland invasion is here not only certain, but inevitably early as well.

Aids in recognizing this stage: (1) The duration of the ulcer. (2) Its obstinacy to treatment. (3) The age of the patient. (4) Absence of any induration or fixity. (5) Careful scraping of the surface of the sore, and microscopic examination.* In doubtful cases, after cleaning the surface, scrape lightly with a spatula, or blunt knife, and examine the result with a quarter-inch lens. If the epithelium be only undergoing an inflammatory change, not as yet malignant or pre-cancerous, the cells have the usual polygonal shape, they are well formed, of about the same size and the same regular shape, and the nuclei are small in comparison with the large size of the cells. On the other hand, if the change present be no longer inflammatory, as in a syphilitic ulcer, *i.e.*, if a pre-cancerous condition be setting in, the cells present a widely different appearance. They are now no longer regular, but variable in shape and size; very few of the square polygonal ones are seen; the great majority now are tailed or oval, sometimes withered or dried up. Their nuclei are much larger than in the cells of normal epithelium, and sometimes several nuclei are present. I have given instances of this in the plate which accompanies the paper referred to (Figs. 3, 4, 5, and 6).

Questions Arising before Operation.

The operating surgeon will often be called upon to give an answer to the two following questions:—Will the disease be permanently cured? If a permanent cure is impossible, will life be bettered and prolonged?

A. ***Will the disease be permanently cured?***

Really permanent cures are, as yet, too few, 10 per cent. of cases operated on (Barker);† 13 per cent. (Butlin).‡ The explanation of this is not altogether to the credit of our profession. Patients and we, alike, are too often both to blame. The gravity of the disease is overlooked, the time of the "pre-cancerous stage" is lost. Because tongue-cancer is so often preceded by syphilis, or local irritation, the practitioner diagnoses the above, and suggests them as the essential part of the mischief: "give drugs another chance"—*e.g.*, potassium iodide, mercury, caustics.* To these there are, in nearly every case, the strongest objections in the pre-cancerous stage. Time is lost, strength is lost, and the patient is lulled and befooled, while all the time the vascularity and irritation all around the ulcer are increased. Furthermore, the patient is in part responsible for the delay, as he very naturally dreads the operation, exaggerating its danger, painfulness, and the supposed inevitable loss of speech. We shall never be able to successfully combat the above till (1) the importance and value of the pre-cancerous stage are recognized; (2) getting cases of tongue-cancer early,† we are enabled to assure the patient that removal of one-half of the tongue will be sufficient, and that half can be safely and usefully spared to him.

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* Butlin (*Sarcoma and Carcinoma*, p. 154, pl. iv. Figs. 1, 2, 3). The use of cocaine will nowadays facilitate the above examination.

† *Loc. supra cit.*, p. 604.

‡ *Dis. of the Tongue*, p. 295. Mr. Butlin's percentage is calculated from seventy cases. He is inclined to doubt whether a larger number of cases would afford so good a percentage of recoveries.

B. ***If a permanent cure is impossible, will life be bettered and prolonged?***

Cases which are not operated on die within eighteen months, many in twelve months. An operation wisely planned and well carried out often gives a gain of six or eight months. This is a gain not only of time, but also of comfort. Death by glandular recurrence in the neck is less painful and noisome than death by mouth-cancer. No one who has seen much of tongue-cancer will have any difficulty in answering the question which of the two is most painful to the patient and distressing to those around him—tongue-cancer with its horrible fœtor, profuse and foul salivation, its pitiless, incessant, weary, racking aching of tongue, ear, face, and teeth, or recurrence in the cervical glands, an alternative in which the patient is often able to work up to near the last, and, till towards the close, is free from the agonizing tenderness, the stinking fœtor, the dribbling of foul saliva (not only half-poisoning the patient, but rendering him noisome to others ‡), and the slow starvation day by day of tongue-cancer. Where an operation is certainly attended with risk, the patient in facing it may be relieved by the assurance that a life prolonged in hideous misery and constant agony is worse than death following close on an operation. "When a man has only, suppose, two or three years to live, it is no small advantage if at least half the time can be spent in comfort rather than in misery, and in profitable work rather than in painful idleness" (Paget). If a patient cannot make up his mind to an operation, and is losing precious time, he should be warned, without being unduly frightened, of the state of things, alluded to a few lines above, which will inevitably follow. Usually, as soon as this sets in, *i.e.*, when the condition of the tongue renders him a nuisance to himself and others with the disgusting fœtor, the constant dribbling of foul saliva which cannot be swallowed, the weary aching day and night, lit up into agonizing flashes when the parts are touched or moved, the patient becomes willing to run any risk. But, too often, by this time, if the glands are not already enlarged, the mischief has reached the floor of the mouth or the alveolar mucous membrane by extension, though not yet perhaps with ulceration.

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* "While a careful thorough application of nitric acid or acid mercury nitrate is perfectly justifiable in certain cases, and may be highly beneficial, the use of caustics frequently repeated at short intervals is here futile and perilous. For medical men to waste time with this treatment should at the present day be almost criminal, for such dallying with drugs and local applications can only lead to cultivation of cancer, and most miserable and often untimely deaths" (article, *loc. supra cit.*, *Guy's Hosp. Rep.*, 1889).

† If ulceration has been persistent for longer than three months, permanent recovery is very doubtful. If it has persisted for over six months, if more than one-third of the tongue is invaded, if the floor of the mouth is involved, permanent recovery is well-nigh certainly hopeless.

‡ "Recalling the 'male gratus amicis' of Dean Swift. Who has not seen such cases, the close of whose life brings, week after week, days without hope and nights without rest, and has not longed exceedingly for a wider recognition of the pre-cancerous stage of tongue-cancer, and for earlier operations in it?" (*loc. supra cit.*).

Operations.—The following four will be carefully described —viz.:

(i.) **Whitehead's** (Fig. 89).
(ii.) **Syme's** (Fig. 90).
(iii.) **Kocher's** (Fig. 90).
(iv.) **The Écraseur.**

With these, certain aids—*e.g.*, slitting the cheek, preliminary laryngotomy, and ligature of the linguals—will also be considered. One or two other methods will then be briefly alluded to.

While the above operations—and I allude especially to the first three—give a choice which will enable the surgeon to meet any case of tongue-cancer, whichever is chosen must be completely carried out; "niggling" operations lead inevitably to return and accelerated growth in the tongue itself.

(i.) **Whitehead's.**—The advantages of this are very great. They are: (*a*) The transverse section of the body of the tongue can be placed, deliberately, well behind the growth. However far behind the growth the loop of the écraseur is placed before the operation, and however securely it seems to be retained *in situ* by large curved needles, as the loop is tightened up, owing to the enormous strain which is gradually applied, the needles and the loop are forced forwards nearer and nearer to the growth. Now the neighbourhood of this is all ready to become the seat of malignancy. All around the growth the epithelial columns are ready to dip down into the vascular connective tissue beneath, on which in health they never encroach. Again, the parts around are loaded with inflammatory cells, soft and vascular. If, as is very likely, owing to the tremendous tension to which it is submitted, especially when the parts are very soft, the loop comes crushing into this neighbourhood and makes the section here, the indipping processes which extend for some distance around the actual epithelioma may, owing to the vascularity and inflammation consequent on the operation, break out into speedy recurrence. Again, the insertion of the needles which are intended to keep the loop well behind the growth is not always an easy matter, especially if the growth is far back, and if the front teeth are well developed whilst the molars and pre-molars are too deficient to allow of wide opening of the mouth with a gag. (*b*) The resulting wound is very clean, there being very little laceration and no charring. The slight decomposition which would take place from an extensive operation, even with scissors, is readily checked by the use of iodoform and ether. The advantage of this in saving a patient, whose vitality is already lowered, from the depressing effects of being liable for days to breathe and swallow with a fetid sore in his mouth, in securing rapid granulation and healing, and thus enabling the patient to be early propped up, and soon to leave his bed, must be obvious to every surgeon who knows how great the risk is of fatal septic bronchitis in these cases. For the same reason secondary hæmorrhage is unknown. (*c*) The instruments required are extremely simple and few, as will be seen from the account of the operation.

The Operation.

It is most essential that the anæsthetic should be in the hands of a man who can be thoroughly trusted. It is often taken badly in these cases, with much dyspnœa and restlessness at first; and, during the operation, owing to the open mouth admitting much air, and the fear of interfering with the operator, the patients often "come to" frequently. The only thing is to get them well under at first; later on it will be well not to keep them too much under the influence of the anæsthetic, in order that, the sensibility of the larynx not being lost, the blood may not enter the air passages. The administrator must watch the tint of the lips, the veins in the cheeks, and know when a little blood is only safely, though noisily, bubbling at the back of the fauces, and when it is getting into the trachea. I look upon the administrator of anæsthetics in these cases as nearly as important as the operator. Two reliable assistants are needed who understand the steps of the operation, one to take the gag in charge, and to sponge when needed, and the other to hook back the corner of the mouth with two fingers while he is ready to sponge, and thus, with the position of the head over to this side, enable the blood to escape freely from the wound into the cheek and out of the mouth, with the aid of deft sponging. Two nurses should be ready to supply sponges; these being absolutely clean, soft, thoroughly wrung out of iced Condy's fluid, and firmly secured on holders. The following instruments should be close to the operator's right hand—viz., scissors,* a pair of torsion-forceps, and Spencer Wells' forceps, a needle in handle, threaded with stout silk, and one or two medium-sized ligatures of carbolized silk.

A good light is absolutely essential. Daylight close to a window is far the best. If it is needful to operate when the above cannot be obtained, as in a succession of foggy November afternoons, a good lamp light, concentrated by a laryngeal mirror, will be useful. In making arrangements for a good light, the surgeon will remember that, while the removal itself takes but a short time, getting the patient under the anæsthetic, and keeping him under its influence, often render the operation much prolonged. It may not be superfluous to add here that this is an operation which calls for coolness and decision on the part of the operator, and for promptness with their help on the part of all those who assist. No crowding on the operator, no obstruction to the light by bystanders, should be permitted for a moment.

Preliminary Laryngotomy.—The question of the advisability of this operation now arises. It forms no part of a "Whitehead" proper. The operator who introduced the scissors-method, and whose success with it is so well known, never, I believe, uses a preliminary laryngotomy. In my first 6 cases I followed him closely. In the later 24 I have performed laryngotomy on many occasions, though I fear Mr. Whitehead will consider this admission on my part as a sign of "falling away." With a wider experience, I am led to think very highly of this preliminary step, and of the plugging of the back of the mouth, which it renders safe, and I do so for this reason. With the fauces plugged, and the patient breathing through a laryngotomy cannula, the surgeon can neglect the hæmorrhage more, can operate more deliberately, and thus (and this is the value of this preliminary step in my mind), at every step of the operation, can have the parts more thoroughly sponged dry, and thus be enabled throughout to keep more surely wide of the disease. In other words, I do not dread the hæmorrhage which accompanies a scissors-operation for itself, but because it is liable, in spite of careful and prompt sponging, to obscure the field, and thus lead to cutting dangerously near the growth—a danger especially likely to happen if the hæmorrhage is at all free, if the parts cut are very much softened, and if the patient is not taking the anæsthetic well. For these reasons, I am inclined to recommend a preliminary laryngotomy, with plugging of the fauces, in these cases :—(1) When a surgeon who values Whitehead's operation is doubtful as to his means of meeting hæmorrhage. (2) When the growth extends beyond the middle of the tongue, into the posterior third. (3) When the floor of the mouth is at all involved. In growths limited to the anterior half of the tongue, unless there is much fixity, laryngotomy is not needed, for, as will be seen below, sufficient of the tongue in such cases, after very little use of the scissors, comes right out of the mouth.

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* Mr. Whitehead, hearing in 1881 that I had twice operated by his method, kindly sent me a pair of his scissors. They are rather longer than usual, perfectly flat, very sharp up to the tips, which are square and blunted.

If it is decided to perform laryngotomy, this operation is done as at p. 384, and a soft clean sponge, dusted with iodoform, is tied with silk into appropriate size and fixed at the back of the fauces, the silk being brought out of the mouth and held by a finger of the assistant who has charge of the gag. This sponge must be pressed well back, and care taken that it does not draw back and down the base of the tongue, or it may cause some difficulty in securing the linguals when the transverse section of the tongue is made far back. The anæsthetic is now continued through the tube, an additional advantage, brought about by the laryngotomy, as the administration of the anæsthetic does not interfere with the field of operation. So very little sloughing and swelling of parts follows on Mr. Whitehead's operation that the laryngotomy tube may usually be removed as soon as the patient is back in bed, and has "come to" comfortably.

Whether laryngotomy is performed or not, the patient, being propped up, is brought quite to that side of the table on which the surgeon stands. A gag* is placed on the side of the mouth opposite to the growth, and the mouth widely opened. The tongue is then transfixed on the diseased side well back in its anterior third, with a needle in a handle loaded with stout silk, this is looped and knotted, and the tongue thus well drawn out of the mouth. The surgeon then, with a sharp-pointed bistoury, splits the tongue longitudinally along the raphé, to a point thoroughly well behind the growth. This is another departure from a strictly performed "Whitehead," but it has the following advantages, while it causes no troublesome hæmorrhage if the blade be kept in the middle line: (1) If the whole tongue is to be removed it places the hæmorrhage much more under the control of the surgeon, as he can deal with each half separately, and with one lingual, securely, at a time; (2) It enables the surgeon to leave half the tongue if he find it safe to do so. It has been said that leaving half the tongue is useless, the part left being but little under the patient's control. I am of an opinion entirely different, for reasons given below.

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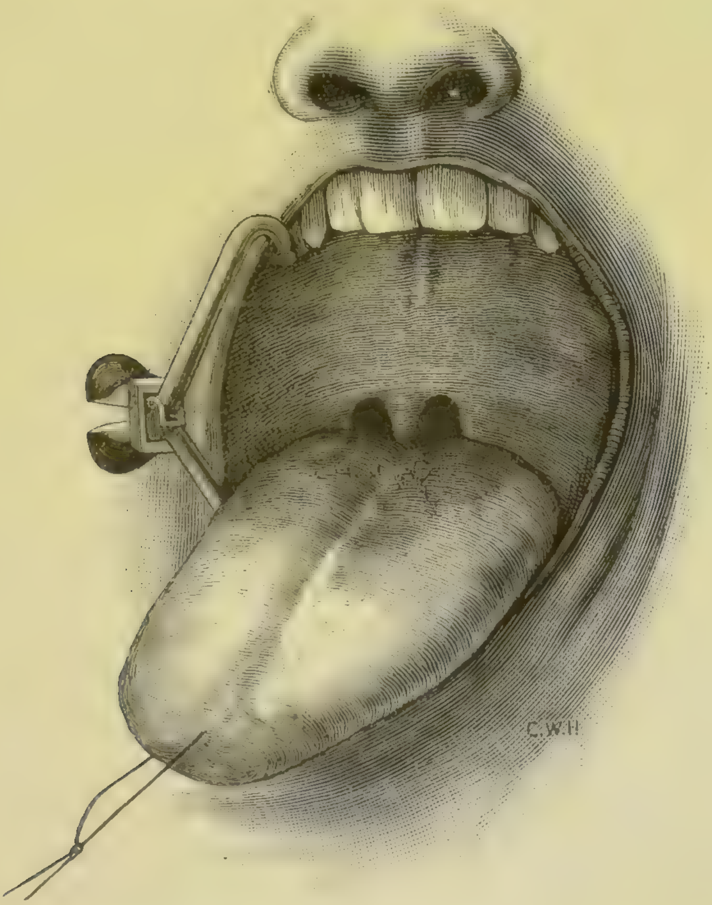
* Of these I prefer Krohne and Sesemann's modification of Mason's gag as the best all-round instrument. It was first brought to my notice by Dr. Hewitt (Fig. 89), who has found it the readiest and most efficient in case of need in the administration of anæsthetics. A gag is still needed for edentulous jaws. The best is a dentist's gag.

FIG. 89.



The tongue having been split and the diseased half drawn well out of the mouth, the surgeon next divides with scissors the mucous membrane between the tongue and the alveolar process, keeping close to the bone so as to be wide of the disease. The anterior pillar of the fauces is next divided. While the above steps are taken the two assistants sedulously sponge away any hæmorrhage into the hollow of the cheek and out of the mouth, the cheek being retracted as above directed. Careful sponging, and sponge pressure on bleeding points, are most essential if the surgeon is to cut wide of the disease.

If the disease has implicated the frænum and its vicinity, two or three of the lower incisors should be drawn so that the scissors may be introduced on a level with the disease. If this is not done, the scissors have to be dipped in over the teeth in an awkward way, and one which, as soon as bleeding occurs, makes it impossible to make sure of getting below the disease. The scissors can be introduced with much greater facility, and used to much better purpose, if a gap is made in the teeth. These can be kept, and fitted to a plate later on by a dentist.

When half of the tongue has been freed all round, the muscles between it and the floor of the mouth are cut through with a series of short snips until the diseased half is separated on the level of the lower part of the jaw, as far back as is needful. During this stage oozing will take place, and one or two small arteries jet with varying freedom in different cases, but these will yield to pulling steadily on the tongue and to firmly applied sponge-pressure.

The tongue having been freed horizontally up to a point well behind the disease, the transverse section is now made, and here I have found the following precaution useful:—Instead of cutting straight across the half and trusting to being able to secure the lingual on the face of the stump, a step by no means always easy of accomplishment, owing to the artery being often at once obscured by a small pool of blood, and to the not infrequent softness of the tissues in these cases, I cut a deep groove through the tough mucous membrane of the side and dorsum, and tear through the softer muscular tissue with the closed scissors or a steel director till the lingual nerve and artery are seen, then, having applied a long-bladed pair of torsion-forceps to the remaining tissues, cut away the half of the tongue in front of the forceps, and then twist or tie the lingual artery which has thus been secured.*

If it be needful, the surgeon then proceeds to deal with the other half of the tongue, a step which is much facilitated by the room given for manipulation by the removal of the first half.

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* If any difficulty occur in dealing with a divided lingual, especially if the tongue has been divided far back, a suggestion of Mr. Heath's will be found most useful—viz., to hook one or two fingers into the pharynx over the stump of the tongue, and to draw this forwards, thus at once arresting the hæmorrhage by pressure, and bringing into view the bleeding point.

Removal of Half the Tongue.—On this subject I may quote again from my article in the *Guy's Reports*, p. 252: "(1) The removal of half the tongue is suitable and strongly called for in certain cases. (2) That such an operation, performed in fitting cases, leaves the patient with an organ which is (*a*) safe from recurrence, (*β*) a most useful one in speaking, swallowing, &c. (3) That it is only by operating early in these cases, and by thus being in a position to promise the patient that the less severe operation will be sufficient, and will give him immunity from disease and leave him with a most useful organ, that we shall ever attain to better success in our operations for cancer of the tongue, removal of the tongue being a mutilation especially dreaded and deferred by the patient." Two cases are then given in detail in which I had removed half the tongue. "*The condition of the tongue subsequently to removal of one half longitudinally.*—Having seen the male patient lately, fifteen months after the operation, a short account of the condition presented by his tongue and mouth will not be out of place. On looking into the patient's mouth, the tongue is seen to be directed constantly over to the left side by the unbalanced fibres of the right half, the tip especially being curled round to the left side and a little backwards. The mucous membrane on the floor of the mouth on the left side is, as is always so in these cases, loose and prominent from the constant dragging on it of the remaining tongue. *Mobility.*—When the patient is asked to protrude his tongue beyond the lips, there is nothing in the mouth to prevent his tongue from doing so; the tongue is pushed out between the lips, but owing to its tendency to curl round towards the left it does not come beyond them. From the same cause Mr. C. is unable to touch the right commissure of his lips with the tip of his tongue. When asked if he can touch the hard palate with his tongue, he can do so when the teeth are half an inch apart, not when the jaws are widely separated. *Speech.*—Mr. C.'s own account is that he is always intelligible, save when 'excited, as in talking politics.' His voice is loud and ample. His speech is clear and intelligible, save when one or two consonants, especially two dentals, requiring rapid touching of the incisors or hard palate by the tip of the tongue, succeed each other closely, as in the word 'literal.' *Taste.*—This, the patient says, is absolutely unimpaired. *Mastication.*—It is here only that Mr. C. allows that any difference is to be noticed since the operation. Thus in certain actions, *e.g.*, chewing up a bitten piece of apple, manipulating a portion of herring so as to avoid swallowing small bones—in such actions as these he states that 'the left half of his mouth does not act as well as the right, the latter having a little more work to do.'"

Where, in fitting cases, it is possible, after splitting the tongue, to leave one half of it, this part will be found most useful in speaking, swallowing, &c., and I am further most strongly of opinion that if patients could be assured that, by early operation, half only of the tongue would require removal, they would submit much more readily to an operation which they dread so peculiarly, and to the grievous putting off of which is due the very small percentage of permanent cures.

Slitting the Cheek (Fig. 90).—This step is an excellent one. It may be made use of in cases where the disease is situated very far back, extending close to or on to the anterior pillar of the fauces, where the hæmorrhage is expected to be especially free, where the light is unavoidably very bad, or where there is unusual difficulty in getting the jaws well apart. The cheek is slit as far back as the anterior border of the masseter, the facial artery and other small branches being secured at once. The parts require most careful adjusting afterwards, especially at the corner of the mouth, where, from the dribbling of saliva, primary and exact union is not always secured.

Preliminary Ligature of the Linguals.—This step has been very largely practised by Prof. Billroth.* Unfortunately he expresses no opinion as to its value. He states that he ligatured the artery twenty-seven times (apparently in all as a preliminary step), but only adds that no secondary hæmorrhage ever followed, and that the wound always healed satisfactorily.

Dr. Shepherd, of Montreal, has recorded† three cases in which he tied both linguals previous to excision of the tongue, which operation was bloodless.

I have never taken this precaution myself, and I do not recommend it, for the following reasons:—(1) In three cases in which I know of this precaution having been taken, the hæmorrhage was as free as in the usual operation with scissors, performed without any such preliminary.* (2) I think that an experience derived from operations in thirty cases justifies me in saying that if the operation with scissors be performed with attention to the details given above, the hæmorrhage is not so difficult to deal with as to require this precaution.† (3) The ligature of both linguals is by no means an operation that can be done quickly,‡ and requires a good light. It may thus take up a good deal of the time required for dealing with the disease of the tongue itself. If it be answered that diseased glands can be dealt with at the same time and by the same incisions, I must state, in no contradictory spirit, that I am of a distinctly contrary opinion. Removal of epitheliomatous glands requires of itself much time and painstaking, lying, as they do, in long chains, and in relation with most important structures. If they are to be removed with that thoroughness which alone justifies any attack on them, this should be done with the full allowance of time and the undivided attention which are given by a separate operation, either before or after that on the tongue.

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* *Clin. Surg.*, Syd. Soc. Translation by Mr. Dent, p. 113.

† *Ann. of Surg.*, November 1885. Mr. Treves (*Lancet*, April 21, 1883) publishes four cases of the removal of the tongue, in which ligature of the linguals was resorted to. The hæmorrhage which followed on the operation on the tongue is stated to have been "very insignificant, and usually immediately arrested by firm pressure with a sponge. It is only far back, in the region of the tonsil, that any bleeding may occur that does not cease almost spontaneously."

(ii.) **Syme's Operation** § (Fig. 90).—This consists in dividing the symphysis menti and then removing the whole tongue and floor of the mouth with knife or scissors, or, partly with one of these, and partly with the écraseur.

It is a far more serious operation than the one already given, and often involves prolonged after-treatment, owing to the tardy union of the jaw. It should be reserved for those cases in which the ulcer involves the floor of the mouth, or in which, in addition, to an ulcer on the side, a hard mass of infiltration can be felt in the substance of the organ. Where this operation is contemplated in an aged or broken-down patient every attempt should be made to improve the general health previously. An anæsthetic being given, and a preliminary laryngotomy performed, the patient's head and shoulders are raised, and the surgeon divides the soft parts of the chin, as far down as the hyoid bone, if the soft parts in the floor of the mouth are much implicated. The vessels being secured, the jaw is drilled below the teeth $\frac{1}{4}$ inch on either side of the middle line, and then sawn through.* A sponge is now placed at the back of the fauces, and the halves of the jaw being forcibly retracted, the tongue is well drawn out by a loop of silk, the mucous membrane snipped through between the tongue and the alveolar process, and the anterior pillars next divided. The genio-hyoglossi † and genio-hyoids are next divided, and the tissues in the floor of the mouth separated as deeply as necessary with the scissors or blunt-pointed bistoury aided by the finger, partly by cutting and partly by tearing, any vessels that require it being tied or twisted. The tongue being thus freed laterally and below as far back as is needful, the transverse section is made, one-half at a time, with the precautions recommended at p. 366.

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* The operations were here performed by two of my colleagues, and there could be no doubt that the vessels were secured.

† In writing this I am taking it for granted that the surgeon will be aided by helpers as apt and ready as I have been fortunate enough to find.

‡ The operation is fully described, and its difficulties entered into, at p. 482.

§ *Lancet*, 1858, vol. i. p. 46, and vol. ii. p. 168. See also the account by Dr. Fiddes of his case, *Edin. Med. Journ.*, vol. iv. p. 1092. As a proof of the severity of this operation both of Prof. Syme's first two patients died.

The floor is now carefully inspected, and any suspicious patches or enlarged glands most carefully removed. In raising the former, before using the scissors, a tenaculum is often very useful. If it be preferred, though I in no way recommend it, as soon as the attachments of the tongue to the floor and sides of the mouth are sufficiently divided, the transverse section can be made with an écraseur, the loop of which is slipped over the tongue and kept in position by two curved needles as at p. 373.

The two halves of the jaw can then be wired, but to promote speedy union a cap of vulcanite or silver had best be fitted on to prevent displacement of the fragments. A drainage-tube should be brought through from the mouth to a point just above the hyoid bone, before the soft parts are united with sutures.

(iii.) **Kocher's‡ Method, by Lateral Infra-maxillary Incision** (Fig. 90).—This operation, like the last, is a severe one; it also opens up freely the connective tissue of the neck. It has the great advantage of enabling the surgeon to deal with mischief far back in the tongue and at the same time of removing enlarged sub-maxillary glands. Furthermore, it can be performed antiseptically. The mouth being disinfected with a 1 in 1000 perchloride of mercury solution, and a preliminary laryngotomy performed, an incision is made from just below the symphysis down to the hyoid bone, and following the digastric muscle back to the anterior edge of the sterno-mastoid, and then up to near the lobule of the ear. The flap thus marked out of platysma and fasciæ is then turned up, and the facial artery tied. The submaxillary region is then thoroughly cleaned out and the lingual artery secured beneath the hyoglossus. By cutting through the mylo-hyoid muscle the cavity of the mouth is now freely opened into, and the tongue brought out through the wound and divided as far back as is needful, one-half being removed after splitting the organ, or the whole tongue removed, the opposite lingual being tied if needed.

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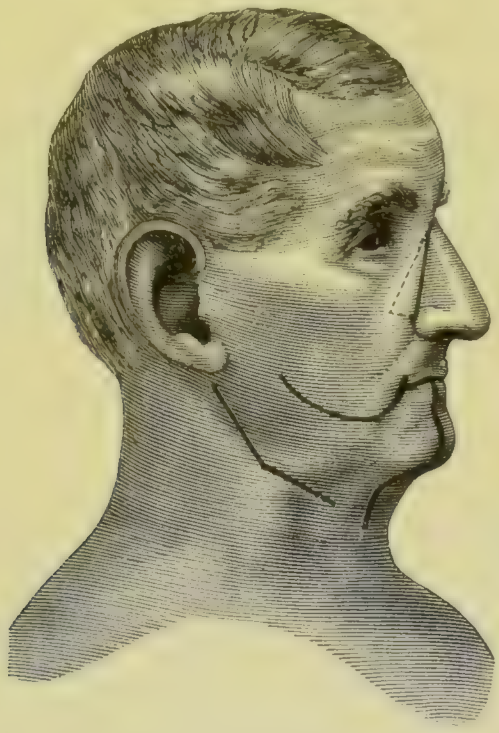
* By some it is advised to saw this somewhat angularly instead of vertically to promote interlocking and union of the fragments. As, however, necrosis may follow this as well as the other form of bone-section, the longer time that it entails is scarcely worth giving.

† If only one-half of the tongue need removal—a rare contingency in the cases which call for this operation—the complete separation of these muscles and the consequent danger of the falling back of the tongue will alike be avoided.

‡ *Deut. Zeitsch. f. Chir.*, Bd. xiii. 1880. Mr. Barker was the first, I believe, to draw the attention of English surgeons to this operation ("Diseases of the Tongue," *Syst. of Surg.*, vol. ii.).

FIG. 90.



The incisions on the nose are those of Ollier for the removal of naso-pharyngeal polypi, p. 312. Below are seen three for the removal of the tongue—viz., that for slitting the cheek, and that of Syme's operation. The third, that of Kocher, should have been brought further forward, curving up towards the chin.

The large wound is then carefully packed with strips of antiseptic gauze, a drainage-tube being first inserted. The patient continues to breathe through the laryngotomy-tube until the wound and mouth are quite sweet, and thus there is no danger of septic broncho-pneumonia.

If it be desired to conduct the operation as strictly antiseptically as possible, before it is begun plugs of salicylic wool must be placed in the nose, the cavity of the mouth well washed out with 1–2000 mercury perchloride solution, and irrigation used at the operation and at each dressing. As, however, it is impossible to render aseptic the closely contiguous cavities of the posterior nares and pharynx, and as the patient will require feeding at regular intervals with a nasal tube, I would prefer to trust to sufficiently frequent changes of the gauze with which the wound is plugged, dusting in iodoform and powdered boracic acid, painting on with a camel's-hair brush iodoform and ether, and securing free drainage by a drainage-tube which has one end brought out of the mouth and the other at the lower and posterior angle of the wound, both lodged in aseptic dressings.

Several English surgeons have lately drawn attention to Kocher's method, already alluded to, of packing the wound with antiseptic gauze and bringing a drainage-tube out into the submaxillary region. Mr. Butlin gives, with especial care, the details with which this method has been employed by Kocher himself, who lost only one patient from the operation in fourteen cases, and by Billroth, whose results, published by Wollffler, show the last seventeen cases thus treated to have been all successful.

I have not myself made use of this method, for these reasons:— I consider (1) that other means give as good results, and in a way more agreeable to the patient, and I may add here that, out of thirty cases of Whitehead's method, I have only lost two * from the operation. (2) That this method of packing with gauze does not, and cannot, give absolutely reliable aseptic results. It would, I think, be easy to prove this from the constant soaking of saliva and other matters, in which this wound differs from others, but no better proof can be given than the fact that a patient on whom Mr. Butlin himself made trial of this method died, on the eighth day, of septic pneumonia.

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* The first of these was a Jew, prematurely aged, with epithelioma supervening on syphilis, who died, on the eighth day, of broncho-pneumonia. I fear that this was septic, though my colleague, Dr. Mahomed, who saw the patient during life, and who made the post-mortem examination, being influenced, chiefly, by the sweet condition of the mouth, was of a different opinion. In the other case, that of an itinerant musician over fifty, much broken down by poverty, exposure, and drink, I had removed the tongue far back for extensive epithelioma. The patient was left in bed, with orders that he should be carefully watched. For some reason these were not carried out. On my return in an hour's time I found him with his mouth full of clot, and a porringer half filled with bright blood. This was oozing from a vessel in the floor of the mouth close to the left alveolar arch. As the patient was most unruly, I had ether given for a few minutes, while the vessel was secured. No further bleeding took place, but the patient never "came to" properly, dying about sixteen hours later. His lungs were the seat of old broncho-pneumonia, and his kidneys showed advanced fibroid change, but the additional shock of the hæmorrhage and some blood in his lungs were, undoubtedly, the cause of his death.

(iv.) **The Écraseur.**—This may be used in different ways; the two following are the chief ones:—

1. Through the mouth, in combination with scissors, a method used by Mr. Baker.*

2. By means of a puncture in the sub-maxillary region, or through a wound which has to be made here in the removal of enlarged glands.

The first of these only will be described here, as, if the écraseur has to be made use of, it is by far the simplest and speediest method of using it.

In addition to the instruments already given in the description of the operation with scissors, the surgeon must be provided with a stout, short écraseur, curved on the flat, working smoothly and carrying a strong loop of whipcord, not of wire.†

The first part of the operation resembles that given at p. 364. The tongue being well drawn out with a silk loop, the anterior pillar and the mucous membrane between the alveolar margin and the tongue being cut through, the tongue is then split with a bistoury along the raphé as far back as is needful, and its attachments to the floor of the mouth partly snipped through with scissors, partly torn through with the finger. The tongue being now freed sufficiently to make the transverse divisions, two slightly curved needles, in handles, are made to perforate the tongue a full inch behind the posterior limit of the disease, and the loop is then slipped on and adjusted behind the needles. Before doing this, I would strongly recommend that a groove be cut with the scissors through the mucous membrane of the dorsum and sides of the tongue (p. 366); this simple step will serve to steady the bite of the écraseur and lessen the risk of its gradually coming, as it is tightened up, dangerously near the growth, and it will also shorten the time that the loop takes to effect its work. When first adjusted, the écraseur may be worked more quickly, but as soon as real resistance is felt the screw must be turned more slowly, a half or three-quarter turn being made every minute, or at longer intervals if the loop seems to be cutting too quickly. If oozing takes place from hurried use of the écraseur, it will be far more difficult to arrest on a surface bruised by this instrument than on one clean cut by scissors.

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* *Lancet*, April 10, 1880; *Dict. of Surg.*, vol. ii.

† Mr. Butlin (*Dis. of the Tongue*, p. 334) gives the following case:—The only instance of death from hæmorrhage "in my table occurred in the case of a man whose tongue was removed with a strong wire écraseur, which cut through the tissue of the tongue like a knife, much more quickly and cleanly than had been intended.

When the whole tongue is removed, the écraseur should always be applied to each half separately. Making the transverse section across the whole tongue at once is most tedious, and the great strain is likely to be too much for the loop or instrument itself. It also causes the constricted tongue to swell into a large livid mass, which much obstructs the breathing; and if, as is likely, both the linguals, which are left to the last, are divided simultaneously, the furious spirting of these vessels in two crossing streams is most embarrassing.

I do not recommend the use of the écraseur for these reasons:—

1. However well behind the disease the loop is placed at first (a step by no means easy to secure where the disease is situated far back), as it is slowly tightened up it tends to come forward (even when a groove has been cut in the mucous membrane), gradually grinding the needles placed to keep it in position and the loop closer and closer upon the diseased area, or, if not actually into this, into one from its close contiguity ready to take on disease.

2. I have seen, again and again, however carefully the tightening of the loop has been managed, that this is, finally, not fine enough to divide the lingual artery, which is dragged out in the eye of the loop, and has, after all, to be secured by ligature or torsion, often not without previous furious bleeding.

The galvanic écraseur has not been described. I mention it here only to condemn it. During the operation the loop may break, or it may cut its way too rapidly through the softened tissues, especially if the heat used is too great. Later on, the patient has still to run the gauntlet of the risks of septic lung trouble and secondary hæmorrhage which the use of this treacherous instrument entails.

After-treatment.—The chief objects here are: (1) To keep the wound sweet; (2) to give sufficient food.

The treatment I have made use of is as follows:—For some days before the operation I make the patient practise* frequently washing out his mouth with Condy's fluid, sitting up, and with the head alternately dependent to either side. He also gets used to feeding himself with a drainage-tube attached to a feeder-spout and passed by himself to the back of his throat.†

There was some smart hæmorrhage at the time, and it was not easy to get the man out of the operating theatre alive. The artery was not thoroughly secured, the bleeding recurred, and the patient sank and died a few hours later."

* This gives him something to occupy his mind, and cleanses the mouth.

† If the patient is at all intelligent, he will do this for himself far more painlessly than an assistant can.

After the operation, the cut surface is brushed over with a solution of zinc-chloride, gr. x—℥j,[*] or iodoform in ether; of the two, I prefer the latter at this time. Morphia is given as freely as is safe, with ice to suck, and, if the patient's condition is low, milk and brandy are administered either by a soft œsophageal tube or by enemata. But I have generally found that, after the first six hours, a patient previously practised in the matter will give himself sufficient food.[†]

After the patient has had his first sleep, the surface is brushed over, every two or three hours at first, with iodoform and ether, and the patient is soon encouraged to sit up and wash out his mouth constantly with Condy's fluid. He should be kept warm and free from draughts, and either propped up or turned on to either side. I try that my patients sit up a little on the second day if possible, and get them, when this is feasible, into an armchair by the fifth or sixth day. Yolks of eggs, arrowroot, soups, pulped vegetables in broths, and such like are soon added to the milk and brandy.

Causes of Failure.

(1) Broncho-pneumonia. Pneumonia. Abscess and gangrene of the lungs. These must be placed first on account of their frequency. Septic in their nature, and due to the patient breathing foul gases, and drawing down putrid fluids into his lungs, the treatment must be preventive, every endeavour being made to keep the mouth sweet, and to relieve the patient's breathing by attention to the details already given.

(2) Hæmorrhage. This is rarely met with at the time of the operation or soon after, if every spirting artery has been properly secured. It will also be rarely met with as a secondary complication if the wound has been kept sweet. In cases of bleeding, if the application of a silk ligature to the bleeding point taken up by a Spencer Wells' forceps or a tenaculum is impossible, firm pressure with a sponge on a holder should be made use of after all clots have been removed. If the wound is foul, it must be cleansed by brushing it over with iodoform and ether, or with turpentine—a most powerfully cleansing styptic,[‡] and one always to be used in preference to perchloride of iron. If all the above fail, either applying and leaving *in situ* a pair of

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[*] No stronger solution should be used, for fear of causing cellulitis in the submaxillary regions.

[†] If this is not the case, a soft tube must be passed.

[‡] See the remarks at p. 481. If the bleeding is of the nature of oozing, one or two injections of ergotin should certainly be tried.

Spencer Wells' forceps, packed around with soft gauze, or ligature of the lingual, must be resorted to (p. 482).

(3) Cellulitis. Erysipelas.
(4) Pyæmia.
(5) Exhaustion—more rarely, shock.
(6) Œdema of the glottis.
(7) Suffocation from falling back of the tongue.
(8) Recurrence.

CHAPTER XI.

OPERATIONS ON THE TONSIL.

REMOVAL OF NEW GROWTHS OF THE TONSIL.

THE new growths here are most commonly round-celled sarcomata and epitheliomata.

In sarcomata there is steady enlargement of one tonsil in an adult, without pain at first or inflammation, a globular swelling, the size of a walnut, making its appearance, firmly elastic, and tending to infiltrate adjacent structures.*

In the epitheliomata, the patients are older: the mischief often begins "as a sore throat." The mass occupying the site of the tonsil is now much harder and soon ulcerates, forming an excavated ulcer with the characters of epithelioma. The base of the tongue may be involved secondarily. Dysphagia, emaciation, &c., are more rapid here.

Before describing any operations for removal of tonsillar growths, it is right to allude to their great malignancy, owing to the rapidity with which the glands are affected. In this, rather than in the importance of its relations, lies the failure of operations on the tonsil, and no one who has watched the rapidity with which enlargement of the glands at the angle of the jaw takes place in subacute tonsillitis will wonder at this.

Mr. Butlin† writes on this point: "So early in the course of the disease are the glands affected that they may appear as large swellings in the neck within a few weeks of the period at which the first signs of the disease were noticed by the patient. On the other hand, there may be no visible or tangible glandular enlargement until six or more months have elapsed from the first occurrence of enlargement of the tonsil. The disease proves fatal, in very many instances, within a year, or even six months of its first appearance; indeed, few persons survive for more than three-quarters of a year."

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* Especially the lymphatic glands (*vide infra*).

† *Oper. Surg. of Malig. Dis.*, p. 174

Operations.

A. Through the Mouth. **B. By Incision in the Neck.**

A. Through the Mouth.—This method can only be made use of (*a*) in the very early stage of tonsillar new growths, when there is no evidence of glandular enlargement; or (*b*) when epithelioma of the tonsil co-exists with a similar condition of the tongue.

In such cases, the patient's head being suitably raised and supported, in a good light, the cheek on the affected side is divided from the angle of the mouth to the masseter, and the two ends of the facial artery tied or twisted. The mouth is now kept widely open by a gag inserted on the opposite side, the tongue drawn out of the mouth, and the masseter pulled backwards by a retractor. As much room and light as possible being thus obtained, the surgeon divides the soft palate first in the middle line, and then from within outwards with a Paquelin's cautery; he next, either with the same instrument or with a blunt dissector and his nail, dissects around and enucleates the tonsil with the anterior pillar.

Where the growth is at all cauliflower-like in its prominence, the chief part may be first removed with a heated wire or with the Paquelin's cautery, so as to get more room in dealing with the base. In any case the cautery must be used at a dull red heat only for fear of hæmorrhage. The surgeon must be prepared for its leaving indurated tissues which may simulate deposits of growth, and for the tendency of the instrument, as it is quickly cooled down by its contact with succulent tissues, to stick to them. A little additional heat frees it at once, far more satisfactorily than pulling it away.

Mr. Butlin points out that some of the new growths met with here are so easily separable, so circumscribed, if not encapsuled, that there is not the least difficulty in shelling them out.*

Before or during the above operation the surgeon must be guided by the character of the growth and other facts as to the advisability of performing a preliminary laryngotomy.

B. By Incision through the Neck.

(1) *Cheevers' Method.*

The following clear account of the above method, is taken from a case of Mr. Golding Bird's:†—" An oblique incision was made from the lobule of the left ear, downwards and forwards, to the hyoid bone. The superficial structures and deep fascia were divided, a branch of the external jugular vein alone requiring ligature.

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* *Loc. supra cit.*, p. 175. Mr. Butlin allows that, unfortunately, recurrence is not less probable after shelling out. I prefer the method already given.

† *Clin. Soc. Trans.*, vol. xvi. p. 9. The case was one of epithelioma, in a patient aged forty-five.

"An enlarged lymphatic gland was shelled out and the digastric exposed. This and the stylo-hyoid were then divided, and a second hard gland being found, it was also removed; it lay against the internal jugular vein. On retracting the posterior border of the wound and pulling forwards the angle of the jaw, the stylo-glossus and stylo-pharyngeus were seen and divided, fibre by fibre, on a director. Neither the hypoglossal nerve nor the glosso-pharyngeal was observed. The fascia investing the posterior part of the sub-maxillary gland was now slit up, and the facial artery ligatured and divided. The internal jugular vein was now fully exposed for more than 1 inch. The internal carotid was not seen, but, covered with fascia, was felt pulsating. These two vessels being drawn outwards by a retractor, the wall of the pharynx was, by tearing through some yellow fat, fully exposed, bulging to and fro with the respiration. No vessel save the two already named required securing; and at the upper part of the wound was what appeared to be the pes anserina. A second incision was now made through the cheek from the angle of the mouth * towards that of the jaw. There was no hæmorrhage, as the facial artery had already been secured. With the left forefinger in the mouth and the right in the wound, the enlarged tonsil could easily be moved between them, and it was removed, together with the adjacent piece of the pharyngeal wall, by the electric cautery, employing this partly as a knife and partly as an écraseur."†

The patient made a very good recovery, air ceasing to pass through the wound in the neck on the sixteenth day.

In spite, however, of the thoroughness of the operation the disease recurred in the glands within six weeks, and within two months it returned in the throat as well.

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* In Cheevers' method the second incision is made along the horizontal ramus of the lower jaw. If this is made use of, it is made at the beginning of the operation, and the flap thus marked out thrown down. This would give more room for the subsequent dissection (especially in a stout patient), and would be more likely to expose enlarged glands. The incision through the cheek might be made as well, later on, as in Mr. Golding Bird's case.

† Mr. Golding Bird, in his remarks on this case stated that in another case he should open the pharynx with scissors, owing to the difficulty which the use of the cautery creates in knowing whether the required depth has been reached in the extirpation of the growth.

The following remarks of Mr. Golding Bird deserve most careful consideration. After speaking of the entire feasibility of the operation, he says:—"The question of expediency, however, demands the fullest attention; and I am inclined to think that the plan adopted in my second case referred to—namely, feeding by a soft œsophagus-tube, with the alternative eventually of performing gastrostomy—more likely to meet all the real requirements of these cases, unless seen so early that there can be no suspicion of the growth having extended beyond the tonsil, nor of having invaded the lymphatic system except to a very limited and remediable extent."

The account of the next two operations is taken from Mr. Butlin.*

(2) *Czerny's Method.*

A preliminary tracheotomy having been performed, and the larynx or fauces plugged, an incision is made downwards and outwards from the angle of the mouth to the anterior border of the masseter, and beyond it to the level of the hyoid bone. Through this incision the lower jaw is exposed and sawn through, between the second and third molars, from above downwards and outwards, and the two fragments are held asunder. The growth is by this means laid bare, and to remove it it may be necessary to divide the digastric, stylo-hyoid, and stylo-glossus muscles, and the hypo-glossal, glosso-pharyngeal, and gustatory nerves, as well as the lingual and other vessels. The growth is then cut or torn out, and the bleeding points are touched with the cautery. The wound is thoroughly washed out with carbolic lotion, or dusted with iodoform, the fragments of the lower jaw wired, a second wire twisted round the adjacent molars, and the external wound closed with sutures, except at points for the exit of drainage-tubes.

(3) *Mickulitz' Method.*

This is intended to be even more radical than that of Czerny. An incision being made from the mastoid process downwards and forwards as far as the great cornu of the hyoid, the soft parts are raised from the jaw, the facial nerve being preserved if possible, and the periosteum is separated from the outer and inner aspects of the jaw just above the angle. The jaw is then sawn through beneath the periosteum, the tendon of the temporal divided, and the ascending ramus resected. After drawing aside, with strong hooks, the body of the jaw, the masseter, internal pterygoid, digastric, and stylo-hyoid, Mickulitz found that the surface of his wound corresponded as nearly as possible with the region of the tonsil, and, by dividing the lateral wall of the pharynx, he obtained access to the palate, the base of the tongue, and the posterior wall of the pharynx as far up as the naso-pharynx; and by dividing the digastric muscle and the hypo-glossal nerve, he could reach the entrance of the larynx. Mickulitz prefers to do a preliminary tracheotomy, and claims for his operation not only ease in reaching and removing the disease, and in dealing with lymphatic glands, but, further, that the whole wound communicates freely with the outside, and can be dressed antiseptically. So far from the resection of the ascending process being a disadvantage, it offers the positive advantage of giving more mobility of the jaw than is otherwise present after the contraction of the scar which takes place after any of these operations.

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* *Loc. supra cit.*, pp. 176, 177.

Mickulitz's patient was a woman, aged sixty-five, and the disease had existed about four months. She recovered, and remained well for two years, when recurrence appeared in the glands.

CHAPTER XII.

OPERATIONS ON THE AIR PASSAGES IN THE NECK.

THYROTOMY—LARYNGOTOMY—TRACHEOTOMY—REMOVAL OF FOREIGN BODIES IN THE BRONCHI—EXCISION OF THE LARYNX.

THYROTOMY.

Indications.

(i.) Growths which cannot be removed through the mouth, but which do not require severer operations on the larynx itself. The following are the chief conditions which must decide the removal of laryngeal growths by an operation from the mouth or by thyrotomy:—

(*a*) The amount of special laryngeal skill possessed by the operator.

(*b*) The nature of the growth, whether multiple or no, if pedunculated, if recurrent after attempts at removal from the mouth.

(*c*) The extent of the growth.

(*d*) The irritability of the larynx. The amount of self-control of the patient. Any tendency to asphyxia.

(ii.) Large rough foreign bodies[*]—*e.g.*, bits of bone, &c. In a case brought before the Clinical Society[†] by Dr. Taylor and Mr. Golding Bird a bit of mutton-bone was impacted between the vocal cords, where it could be seen with the laryngoscope. It was removed by Mr. Golding Bird by a vertical incision with its centre over the cricoid cartilage, the crico-thyroid membrane being incised horizontally. A tracheal dilator being introduced, the bone was seen at once, and extracted with Toynbee's ear-forceps. The large size of the fragment, its apparently firm position, the fact that the broad surface, and not the edge, presented, together with its position just at the crico-thyroid membrane, led to the external operation being made use of.

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[*] Mr. Holmes (*Med. Chir. Trans.*, 1882) has drawn attention to the fact that large substances may be impacted in the ventricle or between the alæ of the thyroid cartilage without causing any symptoms of immediate urgency. As they are liable to give rise to spreading inflammation of the mucous membrane, they should be removed as soon as possible.

[†] *Trans.*, vol. xvii. p. 214.

Operation.—A preliminary laryngotomy (p. 385) or a high tracheotomy, according to the amount of room required, having been performed, the incision is prolonged upwards, and the skin and fasciæ over the centre of the thyroid cartilage are carefully divided. All hæmorrhage is then arrested, and the cartilage opened along its centre with scrupulous exactness, the thyro-hyoid and crico-thyroid membranes being also divided if needful. The halves being now held widely open, the foreign body is picked out or the papillomata removed.

During the above operation, it may be well to remember the following points. If much hæmorrhage is expected, as in the case of some papillomata (if large or recurrent), it would be well to plug the air passage below, by the side of, and around the tube which has been inserted, either by a sponge attached to silk or by putting the tube into a collar of drainage-tube of sufficient thickness. The division of the thyroid cartilage should be effected from without inwards, a stout knife, bone-forceps, or even a saw being sometimes needed in adults. As soon as the upper part is divided, the surgeon should examine if he has sufficient room without further division, and if it is really needful to cut down lower, the meeting of the cords must be treated with the utmost delicacy, and, if the parts have to be opened out, as little tension and stretching as possible should be thrown upon this spot.*

The removal of papillomata is often attended with much difficulty owing to their friability.† They are best snipped away with scissors curved on the flat, and their bases touched with some powerful astringent, Mr. Parker recommending chromic acid.

The object of the operation being accomplished, and all hæmorrhage arrested, the alæ of the thyroid are united by one or two points of silver suture not passed through the entire thickness of the cartilage. A little iodoform is dusted on, and lint out of boracic acid (warm or cold, according to the feelings of the patient) is kept constantly applied.

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* Mr. Parker (*Dict. of Surg.*, vol. ii. p. 623), advising that, if it is needful to cut the anterior commissure of the cords, the two alæ of the thyroid should not be quite severed, points out that, in children, the parts being elastic, retraction will accomplish much, but that in old people, or where the growth is large or extensive, not only all the cartilage and the thyro-hyoid membrane must be divided, but that, to secure still more room, horizontal incisions may be needed through the crico-thyroid and the thyro-hyoid membranes, close to the borders of the cartilages.

† Mr. Parker (*loc. supra cit.*) found in one case much difficulty in seizing the growths, owing to the reflex excitability set up, notwithstanding deep narcosis. He thinks that the use of cocaine will here be a material aid.

The tracheotomy-tube must not be removed till all risk of intra-laryngeal œdema, &c., has passed by, though it may be early replaced by one of india-rubber. The after-treatment and complications are much as after tracheotomy (p. 394). Coughing will be especially harmful now.

Impairment of the voice is not unlikely to occur after thyrotomy, quite apart from any injury inflicted on the cords during the operation, owing to the cicatrix subsequently involving the anterior commissure of the cords. Other possible causes, in spite of aseptic precautions and gentle handling, are chronic laryngitis, the formation of granulations, impaired movement of the thyroid, or displacement of the cords. Where the masses of papillomata are large, though the removal has been complete, the patient may never be able to dispense with his tube.

LARYNGOTOMY.

In this operation the tube is inserted through an opening in the crico-thyroid membrane. It is called for, in preference to tracheotomy, on account of the greater facility with which it is performed, in cases of emergency, and in those where a tube can quickly be dispensed with.* Finally, it is inapplicable before adolescence.

Indications.

1. Sudden impaction of large foreign bodies threatening suffocation, as when a bolus of food carelessly swallowed lodges in the upper aperture of the larynx.†

2. Before operations likely to be attended with much bleeding —*e.g.*, those on the tongue, jaws, tonsils, &c.—in order that the fauces may be plugged with a sponge.

3. When spasm of the larynx is threatening very suddenly, as in tetanus or aortic aneurism.‡ As a rule, tracheotomy, when there is time to perform it, is preferred in these spasmodic affections, and it will be considered later (p. 385).

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[*] Owing to the proximity of the tube to the cords, this operation is not suited to cases in which an instrument has to be worn for any time.

[†] In these very urgent cases the operation may be performed with, *faute de mieux*, a sharp penknife and a toothpick quill.

[‡] Mr. Erichsen, in his *Surgery*, gives many other conditions for which a high tracheotomy is usually reserved.

Operation.—An anæsthetic will be given in those cases in which laryngotomy precedes another operation; in other cases the patient's head must be kept steady. In either instance the head will be thrown back as far as possible, while the neck rests on a firm support. The precise position of the thyroid and cricoid cartilages is then distinctly made out, the notch in the upper part of the former and the ring of the latter being almost always recognizable. The larynx being then steadied (not squeezed) with the left fingers and thumb, and the skin at the same time made moderately tense, an incision about 1½ inch long is made, exactly in the middle line, over the lower part of the thyroid, the crico-thyroid interval, and the cricoid.

If relief is urgently called for, the knife should pass down to the crico-thyroid membrane at once, and the left index having identified this, the membrane is opened by cutting horizontally just above the cricoid cartilage.

If the surgeon have more leisure, he may reach the crico-thyroid membrane more gradually, feeling his way, using retractors, and perhaps identifying the interval between the sterno-hyoids and the crico-thyroids. The only advantage of this is that all hæmorrhage can be arrested before opening the air-tube.

In inserting the tube, care must be taken that both the crico-thyroid membrane and the adjacent mucous membrane are punctured, and that the tube is really within the cavity of the larynx, not pushed down into the cellular tissue outside it. The cannula, which should be shorter than those used for tracheotomy, of uniform bore throughout, and oval in section. is then secured with tapes.

TRACHEOTOMY.

This operation will be carefully considered under the first of the following indications, and more briefly in its relation to the other ones.

Indications:

1. Croup and diphtheria.
2. Syphilitic and tubercular ulceration, in order to give rest to the crippled part.
3. Malignant disease of the larynx.
4. Acute laryngitis.
5. Certain spasmodic affections, *e.g.*, tetanus, or aneurism of the thoracic aorta.
6. Foreign bodies in the air passages: the removal of those which may lodge in the bronchi are treated separately (p. 407).

TRACHEOTOMY FOR MEMBRANOUS LARYNGITIS.*

General points all bearing upon a successful result:†—(A) The age of the patient. (B) Right time of operating and wise selection of cases. (C) Skilful operation. (D) Painstaking and appropriate after-treatment.

A. **Age.**—Recovery before the age of two is very rare. Some of the youngest cases recorded are Mr. Bell's at seven months, and Mr. Cooper Forster's at eleven months.‡ On the other hand, M. Trousseau considers the frequency with which tracheotomy is unsuccessful in adults with membranous laryngitis is due to the fact that the large size of the larynx retards asphyxia till the bronchi are invaded. Again, the older children are, the more strength have they, and the better the hope of recovery; whereas younger children fail more quickly with their poorer vitality, and the greater facility with which their narrow air passages are choked up with membrane, &c.

Average of Recoveries after Tracheotomy for Membranous Laryngitis.§—One case in three or four is a good average. Prof. Buchanan‖ cured nineteen out of fifty, or one in every 2⅝ cases.

B. **Right Time for Operating,¶ and Wise Selection of Cases.**—The nature of the dyspnœa is very various, and on this account the above two points are most important.

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* Under this head are included the two diseases whose identity is disputed—croup and diphtheria.

† If a little amplified, the conditions chiefly affecting success would run somewhat thus:—1. How far has the operator picked his cases? 2. What proportion was diphtheritic? 3. How many were very young? 4. Was the operation an early or a late one? 5. Was the operator experienced? 6. Was the after-treatment skilled?

‡ M. Bazeau (*Gaz. des Hôp.*, 1867, p. 397) mentions successful cases of tracheotomy in infants of ten and fifteen months. The very youngest cases with which I am acquainted are one in which Mr. Croft operated successfully in an infant, aged six months, with erysipelatous œdema of the neck and chest, and another, still younger, which is quoted in the *Med. Times and Gaz.*, 1880, vol. ii. p. 593.

§ Turning to the results of foreign surgeons, Dr. Lindner (*Deut. Zeitsch. f. Chir.* Bd. xvii. Heft 6) states that after the second year there was a marked improvement. In this year the recoveries amounted to 12 per cent., in the third year they rose to 55 per cent. Dr. Passavant, of Frankfort-on-Maine (*Annals of Surgery*, vol. i. p. 582) gives 67 cases of cure out of 229, or about 1 in 4.

‖ *Trans. Intern. Med. Congr.*, 1881, vol. iv. p. 208.

¶ Those surgeons who recommend an early operation, and I am of that number, rely especially on the establishment of much sucking-in and of undoubted dyspnœa. With regard to the first, Dr. Passavant (*loc. supra cit.*, p. 153) holds that tracheotomy, if deferred, allows prolonged dyspnœa to bring about, simultaneously with retraction of the epigastrium, &c., an action on the lung-surfaces analogous to that of a cupping-glass upon the skin—viz., hyperæmia, stasis, The four following conditions of dyspnœa are met with:—(i.) Dyspnœa rapid, urgent, and localized to the larynx; much anxiety and restlessness; orthopnœa; stridor, the loudness of which is probably proportionate to the degree of obstruction in the larynx and the patency of the small tubes. In Prof. Buchanan's words, it points to a cavity ready to receive air if it could but get it, and to a passage narrowed either by false membrane or spasm, or both. On inspection of the chest, the extraordinary muscles of respiration are seen to be in action, there is much sucking-in of the infra-costal and epigastric, and, later on, of the supra-sternal and supra-clavicular regions. While this sucking-in is vigorous and well marked, the lungs are probably free. Auscultation and percussion are difficult. If the bases are resonant, and show vesicular murmur, it is of good omen. So, too, if the eyes, though starting, are bright, the face suffused, not livid, the lips of fairly natural colour, the cervical veins not much distended, the extremities not cold and the seat of stasis. In such cases the membrane, if present, is limited to the larynx, and the tendency to death is by laryngeal apnœa. Tracheotomy here is not only justifiable, but imperatively called for, if previous treatment has failed; the prognosis is favourable if the operation is not too long deferred. Hopeful conditions:—Sudden onset, previous good health, sub-maxillary glands not enlarged, absence of albuminuria.

(ii.) When the dyspnœa increases more slowly though continuously. The restlessness is less violent, and the respiratory effects less exaggerated. The sucking-in is much less marked, especially above. The chest seems to be impeded in its movements, puffing or heaving out *en masse*, and with difficulty; on auscultation and percussion, instead of vesicular murmurs, or conducted hoarse laryngeal rhonchus, and normal bases, will be found sibilant râles, small crepitation, and deficient resonance. These point to the exudation being no longer localized to the larynx,

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hyper-secretion of mucus, splenization, and atelectasis. With regard to dyspnœa, Dr. Ranke, of Munich, lays great stress upon an early operation: "If a child with pharyngeal diphtheria has become hoarse, and shows laryngeal stridor and difficulty in breathing, which has already led to ever so short an attack of real dyspnœa, that child ought to be operated upon at once." Another practical point bearing upon the right time for operation is the fact that at night-time children often get worse. If, then, a case is advancing, and parents cannot towards the day's close make up their minds to sanction an operation, they may be warned that the patient's condition may call for an operation which will be of necessity hurried, and performed under much less favourable circumstances as to light, &c.

but more probably invading the finer bronchial tubes and air-vesicles, the former being swollen and infiltrated with membrane, the latter clogged with viscid mucus. The tint of the face is now pale or leaden. The operation is here much less likely to be successful, from the extension of the membrane, the condition of the lung and of the right heart. Other unfavourable conditions:—Onset with much asthenia, albuminuria, and enlarged sub-maxillary glands.

(iii. and iv.) Dyspnœa intermittent or paroxysmal. In the former case it is due probably to collections of viscid mucus or membrane in the larynx and trachea. Good power of expectoration is here very important. Paroxysmal dyspnœa means spasm. This, very common in all laryngeal dyspnœa, is especially so in children. The danger of this is obvious, and the question of tracheotomy will have to be decided according to whether the spasms are increasing, and by the distance of the medical man from his patient.

Three chief dangers of deferring the operation too long.

(1) Œdema of the lungs.* Owing to the deficient entrance of air, reflex contraction of the pulmonary arterioles takes place, leading to distension of the main trunk, the right heart, and systemic veins. The bronchial veins being also engorged, serous exudation takes place into the finer tubes and vesicles at the bases, and respiration is thus further impeded.

(2) Thrombosis of pulmonary artery. Owing to the stagnation in front, the blood-current moves more and more slowly, and this obstruction by thrombi is not remediable by operation. The signs of this condition are, increasing dyspnœa, very feeble pulse, and combined pallor and lividity.

(3) Exhaustion of heart. Children if they repair quickly are exhausted quickly also.†

Recommendation of the operation to the friends.—(*α*) In reply to questions as to the chance of cure, the surgeon will answer, with caution, that the operation conduces to cure by removing the most urgent danger, by giving relief to the lungs, and thus also improving the strength by sleep and quiet. (*β*) He will be able to say that if death occur after tracheotomy it will be by exhaustion, not by apnœa most distressing to witnesses as well as to the patient.

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* See also the note, p. 386.

† Prof. Buchanan (*loc. supra cit.*, p. 208) makes an important distinction between sthenic and asthenic cases. In the latter, where the vital powers are rapidly failing, tracheotomy will not save the patient, and scarcely, if at all, mitigates the suffering.

Operation.

Question of Anæsthetic.—A little[*] chloroform is, as a rule, safe and advantageous. It allays spasm and thus improves the breathing. It prevents struggles and promotes sleep afterwards. Any vomiting afterwards will probably be beneficial. It is especially useful in recent and vigorous cases, where the surgeon is very short of assistance, and where, if I may say so, his practical experience of the operation is not large. Under the opposite conditions it is not needed; and it will, of course, not be given where there is any tendency to cyanosis and unconsciousness.

Site of Operation.—High or low, *i.e.*, above or below the isthmus. It will be worth while just to consider here the parts met within the middle line, (A) above, and (B) below, the thyroid isthmus. (A) Skin, superficial fascia, branches of transverse cervical and infra-maxillary (7th) nerves, lymphatics, cutaneous arteries, anterior jugular veins—which, with their transverse branches, are smaller here—deep fascia, cellular tissue, superior thyroid vessels, the isthmus, usually over the second and third rings,[†] and tracheal layer of deep fascia. The importance of this last is twofold: if the trachea be insufficiently opened the tube may be passed between the trachea and the fascia overlying it, embarrassing the breathing and the operator alike. If the wound become unhealthy, this layer, continuous below with the pericardium, may conduct pus into the mediastina. (B) The surface-structures are much the same, but the anterior jugular vein and its transverse branches are much larger. The sterno-thyroids are here[‡] quite close together. The inferior thyroid veins are larger. A thyroidea ima may be present, and the innominate artery cross as high as the seventh ring. The trachea is also deeper, smaller, and more mobile, having no steadying muscles here as higher up. The thymus, too, in young children, might present a difficulty. In addition to the above anatomical objections to the low operation, there are three surgical ones—

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[*] Just enough to prevent struggling during the operation. After the skin is incised, less is needed.

[†] Mr. Parker (*Tracheotomy*, p. 37) says that in children the isthmus is almost always higher up, generally on the crico-tracheal membrane and the first tracheal ring.

[‡] Above, the sterno-hyoids are almost in contact in the middle line, with only an interval of about $\frac{1}{8}$ inch, a strong argument in favour of keeping in the middle line exactly (Parker).

viz., (1) Pus is now more easily conducted into the mediastina. (2) In the same way broncho-pneumonia is more probable from a wound in the trachea lower down. (3) From the proximity of the chest, and its suction-action, the tube is much more pulled into the wound, and if it has to be worn for a long time, the tube and shield may part company.*

Operation.—The instruments required are—a small scalpel, with a triangular-pointed handle to act as a blunt dissector, two pairs of Spencer Wells' forceps, dissecting-forceps, steel director, silk or chromic gut ligatures, one or two wire sutures, pilot, and tube.† They should be spread out ready to hand, as, in an instant, moving the child or beginning the anæsthetic may cause most urgent dyspnœa. The question of the anæsthetic has already been alluded to (p. 389). The child's neck and head, at first raised and relaxed,‡ are stretched over a sandbag or a large bottle wrapped up in a towel, while the hands are secured in the jack-towel which firmly encircles the body. Two assistants are desirable, one to support the head and give the anæsthetic, the other to sponge. It is almost superfluous to add that the light should be the best possible, a laryngeal mirror may be of much use in illuminating the bottom of the wound. The surgeon § with his

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[*] Mr. J. Wood, *Lancet*, 1872, vol. i. p. 317.

[†] The best tracheotomy tubes are those of Mr. Durham, Mr. Bryant, and Mr. Parker. If the first are chosen, they must be of reliable manufacture. The ball-and-socket of Mr. Bryant's tubes allows of free play. Mr. Parker (*loc. supra cit.*, p. 42) argues strongly in favour of angular tubes. He shows that the usual ¼-inch tubes impinge with their lower extremity on the anterior wall of the trachea, thus tending to produce ulceration and grave risks (p. 399). Mr. Parker, I think, entirely proves his point. I have used his tubes, but find the absence of a pilot troublesome in dealing with little children.

Whatever tube is chosen, it should be as large and as short as possible; it should be of the same size throughout, without tapering; the inner tube should project a little beyond the outer one; while the whole tube should fit snugly, standing out as little as possible in the neck.

As to the size of the tubes needful, Mr. Parker recommends a series running from No. 18 to No. 30, French gauge, the most useful sizes for children being Nos. 18, 20, 22, 24, 26, and 28 for the outside tube. On this matter of the size of the tube and its relation to the aperture of the glottis and size of the air-tube, the reader should consult Mr. Holmes (*Dis. of Children*, p. 324), Mr. Howse (*Guy's Hosp. Reports*, 1875, p. 495), and Mr. Marsh (*St. Barthol. Hosp. Reports*, vol. iii.).

[‡] Whenever an anæsthetic is being given in cases of dyspnœa, the patients, whatever the age, should be allowed to choose their own position at first, and any movements or alterations in the position of the head and neck, preparatory to the commencement of the operation, should be carefully made.

[§] He first, as soon as the head and neck are in position, marks the chief spots in the middle line—viz., centre of the chin and manubrium, and (when they can be felt) the hyoid bone and the thyroid and cricoid cartilages, especially the last.

left thumb and forefinger steadies the trachea, and makes it a little prominent as well, without any compression; he then incises the soft parts in the middle line from about the centre of the cricoid* downwards for about 2 inches, cutting well through the fat, often abundant here, and exposing the interval between the sterno-hyoids, he then incises this interval, and, if he has reason to fear hæmorrhage, with the point of a steel director† placed in the upper part of the wound he slits down the remaining soft parts in the middle line till he can distinctly feel or, with the aid of retractors, see the tracheal rings.‡ The point of the knife is often required here to incise surely the tracheal fascia. Until the tube is distinctly exposed the left forefinger and thumb must not be removed from their steadying position on either side. With the blade of the knife held upwards the middle line of the front of the trachea is then punctured, stabwise, and two or three rings divided. Sufficiency of the opening is known by a free and noisy rush of air, accompanied often by the expulsion of membrane, which should be sponged away at once. On the other hand, an inadequate opening will be indicated by the hissing only of air through the slit-like opening, without any free rush and with no escape of membrane or relief of the dyspnœa. In this latter case the first opening must be found by the finger-nail and carefully enlarged.§ The cannula is then inserted on a pilot and secured with tapes *in situ*. Some prefer to use a hook to steady the trachea, and a pair of dressing-forceps to dilate the opening; these are more likely to be helpful in a "low" operation, or where a pilot is not used to insert the cannula. If it be desired to try and remove any membrane,‖ the cannula should not be inserted at once, but the opening dilated with dressing-forceps, or with Mr. Golding Bird's or Mr. Parker's dilator. When inserted, the cannula must lie in the middle line, otherwise there will be troublesome irritation of the trachea and plugging of the cannula.

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* This cartilage is often incised, a point to be, however, avoided. The parts are so small in a child that a tube put in by incising the cricoid is likely to irritate the larynx. Of this the cricoid is the narrowest and a very rigid part. Only the smallest cannulæ can be used here.

† Mr. Whitehead (*Lancet*, April 30, 1887), having found that the sharp point of a director will tear open the thin-walled veins here, uses a raspatory after the skin incision. With this he separates the sterno-hyoids, splits the fascia running from the hyoid to the thyroid isthmus, and then, pushing this split fascia on either side with the raspatory, pulls down the isthmus and exposes the trachea, the whole operation being thus rendered easy and bloodless.

‡ Dr. Buchanan considers the following a golden rule:—"Never plunge the knife into the trachea till the white rings are clearly seen in the bottom of the wound." In cases of real urgency the surgeon must be satisfied with touch and not with sight.

§ If the opening be to one side, as well as too small, a fresh and adequate one should be made in the middle line.

‖ Mr. Parker, one of the chief authorities on this subject, strongly advises that all membrane as well as mucus be got rid of, on account of its impediment to

Chief Difficulties.—(1) Insufficient skin incision giving no room for the deeper work.* (2) Not keeping to the middle line; the abundant fat, and the indistinctness of landmarks—*e.g.*, a flat thyroid in a little child aiding this mistake. (3) Not steadying the trachea. This omission leads to missing the tube altogether. Cutting to one side of it, or cutting into it laterally, instead of centrally, and insufficiently. (4) Hæmorrhage, the chief bugbear of the operation, varies extremely. Generally it is not great. Any artery which springs should of course be tied at once or caught in Spencer-Wells' forceps, and a vein of any size which lies in the way should be caught between two of these forceps before it is divided. Venous hæmorrhage, as a rule, stops as soon as the trachea is opened and respiration established. A sufficient median skin incision aids the meeting of hæmorrhage. With regard to the isthmus of the thyroid, this may usually be neglected by the surgeon; if felt with the finger to be large, it may be depressed.† If encountered in older subjects, or if large in children, it may be compressed by two pairs of Spencer-Wells' forceps before division, or ligatured on either side by passing an aneurism-needle beneath it. If, as very rarely happens, the venous bleeding is very free, and the patient's condition from dyspnœa critical, the trachea must be felt for and opened before the hæmorrhage is arrested. The urgency of the case must here come before the amount of the bleeding. In these cases the moment the tube is opened the patient must be turned well over on to his side. Entrance of blood, to any amount, into the lungs must be avoided as not altogether harmless; it will add to the dyspnœa now, and, later on, may set up broncho-pneumonia.

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respiration, its infectiousness, and the patient's inability to get rid of it himself by coughing after tracheotomy. On this account Mr. Parker recommends gently twirling about a feather (the shorter and finer pheasant-tail feathers are the best) soaked in solution of sodium carbonate, and passed several times, not only down into the trachea, but up into the glottis. Mr. Parker condemns attempts to suck out membrane by putting the lips directly to the wound, as of no service to the patient, and as possibly very disastrous to the operator. The aspirator he recommends is alluded to p. 393.

* As in a colotomy, or any other deep incision, the wound should not be funnel-shaped.

† In children this may certainly be ignored. If the knife is used to open cleanly and sufficiently the deep fascia, and then a fine-pointed steel director to clear the way down to the trachea, the operation will be almost bloodless.

(5) Insertion of cannula. If the trachea has not been steadied, and the rings not clearly made out by sight or touch, the opening will very likely be made inadequate or to one side. Another difficulty may arise here from the tracheal fascia not having been sufficiently cut, or from the tube being pushed down between this fascia and the trachea, this, of course, only further embarrassing the breathing. Lastly, though the tracheal rings are cut, the swollen and inflamed mucous membrane may not have been sufficiently divided, or a false membrane may have, in the same way, been carried before the knife. (6) Little or no relief after insertion of the cannula. Though this may have been well and truly done, it is not followed by the relief which has been expected. This may be due (*a*) to the tube being passed between the trachea and some membrane which plugs it; (*b*) to the trachea and bronchi being blocked with membrane, &c.; (*c*) to the child, owing to the operation being performed late, being practically asphyxiated before the completion of the operation. The indications now are to remove the tube and to clear out the trachea, while artificial respiration is vigorously performed and kept up, the opening into the trachea being kept patent by dressing-forceps or by one of the retractors above mentioned (p. 392). If feathers or brushes fail to reach and remove the membrane, trial may be made of aspiration by the mouth. The best means of effecting this is by Mr. Parker's tracheal aspirator, which consists of a small glass cylinder, 3 or 4 inches long, to one end of which the end of a silk catheter is attached, and to the other an india-rubber tube ending in a mouthpiece (*loc. supra cit.*, fig. 10, p. 53). It can be taken to pieces to facilitate cleaning. Before use a little cotton-wool is packed into the cylinder to prevent any dangerous membrane reaching the operator's mouth. Direct suction should never be performed in membranous laryngitis; where blood alone is the cause of the dyspnœa, it may of course be thus removed.

One or two other methods may be briefly alluded to.

*Method of Bose.**—This is largely made use of in Germany, as it is thought to do away with those dangers which a large thyroid isthmus may present in the high operation. An incision is made vertically in the middle line for about 1½ to 2 inches from the centre of the thyroid cartilage. The cricoid being exposed, a transverse incision is made along its upper border so as to divide the layer of deep cervical fascia by which the isthmus is tied down. A director or blunt dissector is then introduced through this incision, and the fascia and the isthmus with its veins displaced from the trachea and depressed. The upper rings are thus exposed bloodlessly. I have no experience of this operation, but it would appear not unlikely that, even if this layer of fascia were quickly hit off and detached, this additional transverse incision and separation of soft parts might lead to cellulitis.

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* *Arch. f. Klin. Chir.*, Bd. xiv. s. 137, 144; *Brit. Med. Journ.*, 1878, vol. i. p. 572.

Tracheotomy by the Cautery.—This method, used by some in Germany and France,* has found very little favour in England. It is best performed by Paquelin's thermo-cautery, used with a series of light touches. Owing to its toughness the skin should be divided with a knife, and when the trachea is exposed this should be opened in the usual way. This method has no *bonâ fide* advantages. Fatal hæmorrhage has followed its use. The relations of parts are much altered. The heated condition of the soft parts is most unpleasant to the finger as it feels its way before each application of the blade.

After-treatment.

This subject, neglected in most books, is often too little looked to in practice. The question of the most suitable atmosphere for the patient will first arise. By most a tent (readily improvised by converting a cot into a four-poster, by fastening on four vertical pieces of wood at the corners, joining these by four horizontal pieces, and throwing a sheet over all) is recommended, and one side of the cot being left uncovered, steam is conducted thither by one of the different forms of croup-kettles. While fully aware of the need of moisture when the atmosphere is dry, when the membrane tends to crust and become fixed, I am of opinion that the above unvarying rule of cot-tenting and use of steam is disadvantageous. The weakly condition of children with membranous laryngitis, and all that they have gone through, must be remembered. Believing that such seclusion and so little admission of air tend to increase the asthenia, and any tendency to sepsis, I much prefer to be content to keep off draughts by a screen, which allows of the escape of vitiated air above, using steam, if needful, according to the size of the room, fireplace, &c., and according to the kind of expectoration,† whether easily brought up by cough or feathers, or viscid, quickly drying, and causing whistling breathing. If the temperature can be otherwise kept up to 60° or 65°, I much prefer to use a thin flat sponge, often wrung out of a warm solution of boracic acid. The inner tube must be frequently removed and cleansed, every hour or two at first. If the secretions dry on and cling to it, they are best removed by the soda solution mentioned below. At varying intervals between the removal of the tube any membrane, &c., which is blocking it, appearing for a moment at its mouth and then sucked back, must be got rid of by inserting narrow pheasant feathers, and twisting them round before removing them. If the exudation is slight, moist, and easily brought up by cough or feather, sponging and brushing out the trachea are not called for, but they should be made use of when there is much flapping, clicking, or whistling of the breathing, and if this is harsh, dry, or noisy, instead of moist and noiseless, two of the best solutions are sodæ bicarb., gr. v–xx to aq. ℥j, or a saturated one of borax with soda. These may be applied by a hand or steam spray over the cannula for five or ten minutes at a time, at intervals varying according to the relief which is given, or applied with a laryngeal brush, feather, or a bit of sponge twisted securely into a loop of wire. When any of these are used, the risk of excoriation and bleeding, and the fact that only the trachea and large bronchi can be cleaned, must be borne in mind, and with regard to manipulations for cleansing the trachea, and removing the inner tube, it is most important to remember that the caretaking may be overdone, and a weakly child still further exhausted by meddlesome interference. This point requires especial attention from the surgeon in the case of some of the nurses of the present day, who seem to wish to transfer the entire charge of the patient into their own hands.

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* Poinset, *Trach. par le Thermo-Cautère.* Paris: 1878.

† G. A. Wright (*Dis. of Chil.*, p. 164) gives a useful hint from Cocks (*Arch. Pædiat.*, Jan. 1884) that sudden obstruction of the tube is most often due to inspissated mucus, not membrane; this thick mucus is secreted usually about twenty-four hours after the operation, and after three or four days the discharge becomes thinner and more puriform.

There is often much difficulty in getting sufficient food taken. The pain in swallowing, the impairment of the act, owing to the presence of the tube, &c., and thus the facility with which liquids may reach the lungs, the need of waking up the child frequently to give it food, are all facts to be duly remembered. It will usually be better to pass a Jaques' catheter (No. 4 or 6) by the nose, and then to feed the patient, at regular intervals, with definite amounts. Care must be taken to see, by the absence of irritation, that the tube is not in the larynx, and, if the above soft tubes are used, that they do not coil up at the back of the tongue.

The removal of the tube next requires consideration. It should be dispensed with at the earliest possible opportunity, either altogether, or replaced by an india-rubber tube between the fourth and ninth days. Quite apart from the danger, which is inseparable from a metallic tube,* of irritation and ulceration of the trachea, there is this object in getting rid of the tube as soon as possible, that the longer the child is allowed to breathe through the tube the more is the act of breathing through the natural passages allowed to be, as it were, forgotten, with the result that, on the tube being removed, asphyxia is threatened.

Conditions which impede the removal of the Tube.—(1) Prolonged formation of membrane. The longest possible period for this is probably about ten days. Patience and support are the main indications in the treatment here. (2) The larynx is crippled like any other inflamed part. (3) The air-tube is closed by granulations, usually above the cannula. More common than these is obstinate swelling of the mucous membrane. Here the tube must be removed, and astringents and caustics carefully applied from below, with the aid of an anæsthetic if necessary. (4) Closure of larynx by deep ulceration cicatrizing after detachment of membrane. In such a case, with the aid of anæsthetics, the larynx must be opened up by probes of increasing size and laminaria tents introduced from below, and later on by the use of Macewen's tubes (p. 398). (5) Paralysis of the dilating crico-arytenoidei postici, or spasmodic action of the closing ones, arytenoidei or crico-arytenoidei laterales, from fear, excitement, or during effort.† The commonest cause of inability to dispense with the tube is probably due to the rapidity with which the larynx falls into abeyance when a child is allowed to breathe through a tracheal cannula, the patient at this age being not intelligent enough to understand the importance of dispensing with the tube, being perhaps too young to care to talk, and, if older, not realizing the need of again using its voice while all its wants are supplied. With the above condition often goes a nervous dread of having the tube removed, and paroxysms of temper and struggling which rapidly produce embarrassed breathing. Any organic mischief, such as adhesions in the larynx, are, I think, extremely rare, and granulations above or below the tube are more often talked of and given as a reason for inability to dispense with the tube than really seen.

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* Mr. Parker points out (*loc. supra cit.*) that black patches seen on the outer tube when removed may indicate ulceration of the trachea, and show the need of changing the tube.

† In a case in which I had performed tracheotomy, and was watching the child for the first few hours after the tube had been dispensed with, most urgent symptoms came on during the slight straining which accompanied an action of the bowels, the child falling off the night-stool on to the floor apparently lifeless. Artificial respiration restored the child, and the case did well.

But while real organic mischief is rare and the usual cause is due to conditions which would seem to be only temporary, it is well known that, in some cases, getting a little child to dispense with the tube is a most baffling and prolonged affair. The following points are worthy of attention. Early attempts to remove the cannula, whether metal or india-rubber. A reliable nurse, ability on the part of the surgeon so to arrange his time as to be himself frequently present at first, and, in the intervals, to be represented by an assistant who will not replace the tube before it is absolutely necessary to do so, and who can dilate the opening with a pair of dressing-forceps, and perform artificial respiration if these steps are required. Shortening the india-rubber tube, till eventually little more than the shield is worn, the child being comforted by the apparent presence of the tube. Encouraging the child to make use of his larynx by breathing through the tube and expiring through the larynx while the tube is closed. Patiently persevering efforts to get a child to talk, or in the case of a younger one to use his larynx by blowing out a spirit-lamp or using a penny trumpet.*

All this time every attempt should be made to improve the general health. Wise feeding—too frequent or too large meals provoke dyspnœa—attention to the bowels, such tonics as Easton's syrup, proper clothing, cold or tepid sponging followed by friction, change of scene and air in every possible way, especially to the seaside.

In a large majority of cases the above treatment, aided by patience, tact, and time, which allows of development of the air-passages, will suffice. In a few the attempts at removing the tube will still fail. Where this is so, and in fact in any case where the use of the tube seems likely to be protracted, the larynx should be dilated—a step which is brought about by simple means, as the larynx is usually merely functionless from disuse, not blocked up, or the glottis closed—by a tube through which the child is made to breathe.

In a recent case the simplest way of effecting this is, after chloroform has been given, to remove the tracheotomy tube, dilate the wound if needful, and pass upwards from it a drainage-tube or catheter with a double silk web; the upper end of this is drawn out of the mouth (with the aid of a gag if needful), and tied to the lower end which projects through the wound. The tracheotomy tube is then replaced for a day or two, and on the withdrawal of the tube from the larynx it can usually be dispensed with altogether. Another very simple and efficient means is thus given by G. A. Wright (*loc. supra cit.*, p. 165) :—" A flexible probe should be passed up through the glottis from below, and a piece of silk carrying a small sponge be attached to it; the probe should then be drawn out through the mouth, and the sponge carried through the larynx sweeps it out, breaks down any adhesions, and clears away mucus or any granulations."

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* I may advise my readers to consult a most practical paper by Dr. Steavenson (*St. Barthol. Hosp. Reports*, 1881).

In cases of longer standing the above simple treatment may not be sufficient, and here the use of Macewen's tubes passed through the larynx* and into the trachea below the wound should be made use of. Chloroform being given, one of the above tubes —they resemble stout gum-elastic catheters with terminal carefully bevelled openings—is passed from the tracheal opening† up through the larynx into the mouth. Having hooked this end out of the mouth,‡ the surgeon now passes the other end down the trachea beyond the wound, a step sometimes accompanied with much difficulty, and one which is aided by the pioneering use of probes and small bougies or catheters. The object of the surgeon should be to place this lower end of the tube only just below the tracheal opening, so that air is drawn in from the end projecting through the mouth into the trachea, without leaving any needless length of the tube here or in one bronchus for fear of setting up irritation and secretion. To prevent the child pulling out the tube, the hands should be secured for the first few hours, and to prevent the tube being bitten, it is well to pass a piece of drainage-tube§ over the first few inches. This end is then secured with tapes around the head. The tube may be left in from twelve to eighteen hours according to the amount of secretion and the facility with which the tube is blocked. While this treatment is being carried out it is well to isolate the child in a separate ward, as the breathing through the tube is very noisy, being often accompanied by very loud bubbling sounds, and the aspect of the child while this necessary dilating of the larynx is going on is one of apparently great distress. When it is evident the tube is clogged it must be withdrawn and cleansed, and, a little anæsthetic being given, again inserted. At any time, if needed, the cannula must be re-inserted and artificial respiration performed. It will readily be understood that during this time the presence of the surgeon, and reliable assistants who will not lose their heads, and nurses with much tact and temper, are pre-eminently required. Even when laryngeal breathing is restored and the tube has been dispensed with, the child must be carefully watched, especially at night. If natural breathing fails, it is better, whenever there is time, to replace the Macewen's tube through the larynx rather than to re-insert the tracheotomy tube into the old wound, a mode of relief which is too likely to be resorted to on account of its facility, but one which tends to keep up the sinus-like nature of the wound in the trachea, and brings back that most pernicious tendency of the child to prefer and confide in this mode of breathing.

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* See a paper by Mr. Bilton Pollard (*Lancet*, 1887) on this subject.

† It is more easy to pass the tube this way owing to the facility with which the tube, when passed from above, finds its way into the œsophagus.

‡ The tube will be found to pass readily behind the soft palate.

§ This simple means is much better borne by the child than the gag. I owe its suggestion to an old friend, Arthur E. Poolman.

Complications of the After-treatment.

(*a*) *Hæmorrhage.*—This is not common; if immediate, it is due to some vessel having been left unsecured. Later on, it may be brought about by ulceration of the trachea by the cannula,[*] separation of the false membrane by sloughing; a velvety and swollen condition of the mucous membrane; or by prominent granulations. The treatment is clearly preventive, to dispense with a tube, especially a metal one, as soon as possible, and from the first to use one of appropriate length and curve (p. 390).

(*b*) *A Sloughy Condition of the Wound.*—If this is threatening, attention must be paid to the tightness of the tapes, so that the cannula is not needlessly buried in the wound, and to the wearing of a collar of lint behind the shield. The tube must be removed at intervals, or replaced by an india-rubber one, air tending to enter without a tube as soon as the edges of the wound are set and healing. If the wound is not only sloughy, but gangrenous and diphtheritic, in addition to frequent cleaning with a camel's-hair brush, the use of iodoform and hot boracic or zinc chloride lotions, stronger measures, such as the application of pure nitric or carbolic acid, will be called for. The general treatment will not, of course, be neglected in these cases.

(*c*) *Emphysema.*[†]—This is usually the result of a faulty operation. The incision into the trachea is either wrongly placed, *i.e.*, it is not in the same line with that in the soft parts, or it is too small—perhaps two small ones have been made; very rarely is the emphysema due to too large an incision in the trachea. Or, the incision may have been correctly made, but some fault connected with the tube may produce the emphysema; thus it may have been originally too short, or have been pushed out of the wound by swelling of the soft parts, or by coughing. As a rule, this complication is not dangerous unless it be extreme in very young children, or unless it travel deeply; under these circumstances scarification must be made use of, if possible.

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[*] Some undoubted cases of ulceration into the innominate after low tracheotomies in children are on record—*e.g.*, *Path. Soc. Trans.*, vol. xi. p. 20.

[†] On this subject the reader should consult the laborious, accurate, and researchful papers of my old friend Dr. Champneys, in vols. lxv. lxvii. and

(*d*) *Ulceration of the Trachea.*—This is usually due to the pressure of a cannula faulty in length or curve, much more rarely to separation of membrane or sloughs. There are no definitely characteristic signs of this complication; the following point to it:—Streaks of blood expectorated a day or two after the operation, and perhaps discoloration of the lower end of the tube. This accident is especially likely to occur in cases of diphtheria, as the vitality of the tissues is here much lowered. The tube should be left out if possible, or an india-rubber one substituted, and worn as short as possible, and cut obliquely so that the end does not impinge upon the anterior wall of the trachea. If it is necessary to dispense with all tubes, attempts may be made to keep the edges of the tracheal wound stitched to that in the soft parts for a few hours, or Mr. Golding Bird's dilator may be worn.

(*e*) *Suppuration in Mediastina.*—This is a rare complication. When it does occur it is liable to be very rapid. It results from a descending cellulitis from the wound. The only treatment is prevention by a well-performed operation and by attention to the wound.

Other complications which are not surgical may of course be present—viz., Extension of exudation downwards. General infection. Paralysis. Albuminuria. Broncho-pneumonia, a very

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lxviii. of the *Med. Chir. Trans.*, and his work on *Artificial Respiration.* The following are amongst the practical conclusions with which his pages abound:—(1) Emphysema of the anterior mediastinum, often associated with pneumothorax, occurs in a certain number of tracheotomies. (2) The conditions favouring this are, division of the deep cervical fascia, obstruction to the air-passages, and inspiratory efforts. (3) The incision in the deep cervical fascia downwards should not be longer than needful; it should on no account be raised from the trachea, especially during inspiratory efforts. (4) The frequency of emphysema probably depends much on the skill of the operator, especially in inserting the tube. (5) The dangerous period during tracheotomy is the interval between the division of the deep cervical fascia and the efficient introduction of the tube. (6) If artificial respiration is necessary, the tissues should be kept in apposition with the trachea, and any manipulations performed without jerks.

frequent one, known by a rise of temperature with frequent respiration and dyspnœa, dulness on percussion, bronchial breathing, with large bubbling and crepitant râles.

TUBAGE OF THE LARYNX AS A SUBSTITUTE FOR TRACHEOTOMY IN MEMBRANOUS LARYNGITIS.

This is one of those new modes of treating an old disease about which it is difficult to give a decided opinion, as the matter is still *sub judice*.

Attention was called to this subject by Dr. Macewen* in 1880. It has been, recently, more prominently brought forward in America.†

The advantages claimed, if verified, will no doubt be very great. Of these the chief are—(1) That objection on the part of friends is less likely than in the case of tracheotomy ; (2) That the tubes are easily and quickly introduced ; (3) That there is no severe and difficult operation ; (4) That the inspired air is warm and moist ; (5) That the tubes are self-cleansing ; (6) That there is no prolonged after-treatment.

The tubes used have been mainly of two kinds—(*a*) Macewen's long cylindrical tubes of the pattern of gum-elastic catheters, introduced from the mouth into the trachea through the larynx, and removed at intervals of about twelve hours for cleansing ; (*b*) O'Dwyer's short tubes (under 3 inches) of metal with the antero-posterior diameter larger than the lateral. These are self-retaining, partly by an enlarged head which rests upon the ventricular bands, and partly by a fusiform enlargement a little lower down. They are introduced and removed from the mouth by special instruments. A gag must be used.

I am unable to recommend intubation. Within a few months of the appearance of Dr. Macewen's paper I made use of his method in three patients with membranous laryngitis at the wish of my friend Dr. Goodhart. Every one of these came to tracheotomy, most of the drawbacks enumerated below being most strongly present. I ought to say that of Dr. O'Dwyer's tubes I have no personal experience, but I am most strongly of opinion that in children at least they cannot meet with a large amount of general success. Their necessarily narrow chink-like calibre appears to me to be certain to obstruct the free expectoration of mucus, membrane, &c., which is so essential in these cases. Even when this is liquid and abundant, I fear that the tubes will be plugged; when the expectoration is dry, thick, and tenacious, its escape must surely be impossible.

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* *Brit. Med. Journ.*, July 24 and 31, 1880. Dr. Macewen's cases were all four in adults, the two acute ones being cases of œdema of the glottis.

† Dr. O'Dwyer's first paper is in the *New York Med. Journ.*, August 1885. Mr. Symonds, in his summary alluded to at p. 402, gives the following references of papers by followers of Dr. O'Dwyer—viz., Dr. Waxham (*Chicago Med. Journ.*, March 1886 ; *Journ. Amer. Med. Assoc.*, October 24, 1885, and July 23, 1887) and Dr. Ingals (*New York Med. Journ.*, July 2 and 9, 1887). Dr. Waxham's results have no doubt improved, but in the *Chicago Med. Journ. and Exam.*, November 1885, *Ann. of Surg.*, January 1886, four cases are given which were treated by him, after O'Dwyer's plan, of which only one recovered.

Drawbacks:—(1) The tubes are likely to become plugged; (2) There is very great difficulty in getting children to take sufficient food, as swallowing is, in them certainly, much embarrassed—the importance of getting sufficient food down in these cases has already been alluded to, p. 395; (3) Part of what liquids are taken now easily finds its way into the trachea and lungs; (4) The tube may be coughed out; (5) The facilities for extracting membrane, spraying the trachea, &c., are much fewer than after tracheotomy; (6) In introducing the tubes membrane may be dislodged into the trachea.

Mr. Symonds, in a summary * of the results of O'Dwyer's method, and G. A. Wright (*loc. supra cit.*) state that in passing the tubes membrane may be pushed down, thus increasing the dyspnœa, and, with this difficulty before us, they point out that it will be wise, when making use of intubation, to be prepared for immediate tracheotomy: while I feel, I trust sufficiently, that the results of tracheotomy for croup admit of very great improvement, I doubt if intubation will be more successful. I venture to think that this is one of those diseases in which sufficient attention has not been paid to some of the anatomical surroundings. I shall, perhaps, be condemned as holding a pessimist's views when I say that, considering the narrowness of the glottis, its proneness to spasm, the ready downward extension of the disease, the age and rapid exhaustion of the patients, I doubt if it is not expecting too much when a larger proportion of cures are looked for here, either by tracheotomy or, still less I think, by tubage. And while I allow that I have not myself had personal experience of the recent modification of tubage, I would add that I have very lately seen two cases in which the improved method was made use of with much temporary *éclat*, followed by tracheotomy, deferred, but ultimately called for, and by fatal results.

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* *Brit. Med. Journ.*, November 19, 1887.

OTHER INDICATIONS FOR TRACHEOTOMY.

(i.) **Syphilitic and Tubercular Ulceration.**—Tracheotomy is more frequently called for in the first of these, in which also it is decidedly more useful. The conditions which demand it, temporarily, are œdema of the glottis setting in on old mischief, fibroid thickenings which may, later, yield to treatment, and, more permanently, probably, deep ulceration, necrosis, and cicatricial contraction.

In tubercular mischief tracheotomy rarely gives much relief, dyspnœa being now a rarer misery than cough and difficulty of swallowing, both of which are conditions which may be intensified by the presence of a tube.

(ii.) **Malignant Disease of the Larynx.**—Here tracheotomy is often called for. Till statistics of extirpation of the larynx are more complete, the question which of these modes of operative interference has the soundest basis must remain uncertain. One difficulty alone which besets this matter is scarcely to be surmounted, and that is that an increasing number of cases shows that, to be really successful, extirpation of the larynx must be performed early, but how many patients will submit to it at this stage? (p. 411).

In deciding between advising a palliative tracheotomy and extirpation of the larynx the surgeon will be guided by the condition of the disease and that of the patient. The latter operation can alone be justified when the disease is strictly localized. Enlargement of the lymphatic glands, extension of the disease, especially in cases of carcinoma, to the pharynx, back of the tongue or tonsil, should put this operation aside. Again, the condition of the patient, how far he is exhausted, how far his strength is sufficient for such an operation as extirpation, how far he gains ground after a preliminary tracheotomy, have all to be considered.

(iii.) **Acute Laryngitis.**—The rapidity with which this may run a fatal course, especially after exposure to cold in reduced constitutions, is well known. If treatment, including application of strong solution of silver nitrate and scarification of the aryteno-epiglottidean folds and adjacent parts fails to relieve the dyspnœa, tracheotomy should be performed at once to meet the increasing exhaustion.

(iv.) **Certain Spasmodic Affections**—*e.g.*, **Aortic Aneurism and Tetanus.**—Owing to these diseases destroying life, usually, in other ways, tracheotomy is rarely called for here. Occasionally however, the laryngeal dyspnœa which they bring about calls for this operation.

Probably there is no form of dyspnœa more agonizing to the patient, or more distressing to the friends, than that which may accompany thoracic aneurism. The surgeon, however, when called upon to perform tracheotomy in one of these terrible cases, must remember that the dyspnœa may be tracheal as well as laryngeal in its origin, and that it is in the latter only that operation will give relief.

I would refer my readers on this point to one of Dr. Bristowe's interesting Lumleian Lectures,* and especially to this passage :—"Destruction of the functional activity of one recurrent laryngeal nerve is attended with, of course, paralysis of the corresponding vocal cord (which can be recognized by means of the laryngoscope), with impairment of the musical quality of the voice, and apparently with some difficulty of swallowing, owing to the tendency of food to slip into the trachea, but is certainly not necessarily attended with stridor or dyspnœa; in the second place, compression of the trachea involves stridor and dyspnœa, which is often paroxysmal and is liable to end in sudden death, but does not itself interfere with intonation or phonation, excepting in so far as it may render the voice weak by diminishing the supply of wind to the vocal organ." As the paroxysmal nature of the dyspnœa may then be met with in cases of pressure on the air-tube below the larynx as well as in laryngeal dyspnœa, the chief points to rely on will be the result of a laryngoscopic examination, and the freedom of the lungs and air-tube from pressure. Dr. Hall† thinks that "the absence of respiratory excursions of the larynx" points to the chief impediment being below the glottis."

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* *Lancet*, May 10, 1879. Dr. Bristowe goes on to show that the exacerbations of dyspnœa in narrowing of the trachea may be due partly to spasm of the muscular fibres, but mainly to accumulation of mucus below the narrowing, and to the difficulty of dislodging it by coughing.

† *Clin. Soc. Trans.*,, vol. xix. p. 82. Quoting from Gerhardt (*Lehrb. d. Ausc.*, Tübingen, 1871), Dr. Hall points out that in a case of aortic aneurism the following causes for dyspnœa (Dr. Powell, Reynolds' *Syst. of Med.*, vol. v. p. 32) may all be present together :—(1) Undoubted paresis of the abductors of the cords. (2) Though the post-mortem may "not show any very distinct bulging inwards of the trachea, the aorta and sac being emptied of blood, yet I can readily believe that during life, when these parts were distended with blood, considerable pressure was exerted on the trachea, and that this narrowing led to accumulation of the tough mucus which so bothered the patient." (3) Gairdner (*Clin. Med.*, p. 486) states that paroxysms of dyspnœa, closely resembling those of asthma, may be occasioned by compression of one of the pulmonary plexuses.

With regard to tracheotomy in tetanus, the same warning has to be given. In the rarer cases in which tetanus threatens life by asphyxia and not by exhaustion, the surgeon, before performing tracheotomy, must decide where lies the seat of the asphyxia. In the few cases which I have seen in which asphyxia closed life in this disease, the asphyxia was due to spasm of the muscles of respiration, including the muscles of inspiration and those of expiration—*e.g.*, the abdominal muscles also. The fatal spasm thus, usually, not lying in the larynx, tracheotomy seems contra-indicated, unless it were done with the object of relieving, with the aid of artificial respiration, that congested, gorged condition of the lungs which is due to the continued spasm of the muscles of respiration. And it is to be feared that if these steps were taken, the gentle violence of artificial respiration would, as has happened with tracheotomy itself in this disease, only bring on a final and fatal spasm.

(v.) **Scalds of the Upper Aperture of the Larynx.**—Tracheotomy is here usually deferred till late, and its want of success is well known. This is not, however, an instance of cause and effect, the mortality in these cases being rather due to the shock, pain, and inability to take sufficient food. Unless the case is seen late, tracheotomy should not be performed in these cases till a trial has been made of scarification, or rather of acupuncture, by means of a guarded bistoury point, of the mucous membrane of the epiglottis and the glosso-epiglottidean and aryteno-epiglottidean folds, the left fore-finger guiding the point of the instrument. In doing this, the surgeon must remember the amount of dyspnœa which is already present, and the certainty that this will be increased by the struggles of the child, by the finger coming in contact with these inflamed parts, and at any moment the child must be turned on its side, artificial respiration performed, or even tracheotomy resorted to.

(vi.) **Foreign Bodies in the Air-passages.**—We will suppose a child brought to the surgeon with a history of having swallowed one of the usual foreign bodies. Two questions now call for an answer. (1) Is there a foreign body at all in any part of the air-passages? and (2) if so, where is it? In regard to the first question, it is well to remember that the history is often far from clear, especially in children, and the symptoms by no means as obvious as they are often described to be. Thus, the chief aids in distinguishing the entrance of a foreign body from such a disease as membranous laryngitis are the sudden onset and, not unfrequently, the well-marked intermissions. The symptoms characteristic of the entrance of a foreign body into the larynx—viz., the urgent dyspnœa, the cyanosis, the struggling against impending death—may not be got at on account of the youth of the patient, or because no one saw the onset; while if the body has passed from the larynx into the trachea, or into one bronchus, the dyspnœa, brassy cough, and alteration in the voice, may all have disappeared before the surgeon sees the child, and yet he will be expected to give a definite opinion. Again, the body may have been coughed up, and perhaps swallowed. Again, in adults, usually hysterical and egotistical women, who come with a history of cancer, dysphagia, etc., owing to a pin which they aver to be in their throats, the diagnosis will be far from easy.*

Having settled that a foreign body is really present, the surgeon, unless tracheotomy is urgently called for, tries to decide where the body is lodged. A careful examination should be made with a good light and with the finger in the fauces, and with the laryngoscope when feasible, any information about the size and nature of the body having been previously obtained.

(*a*) A large or irregular body, such as bolted—*i.e.*, unmasticated—food, or artificial teeth, usually lodge above the upper aperture of the larynx, and cause urgent and often fatal dyspnœa. If, however, the first attack be survived, bodies of considerable size—*e.g.*, a plate with one or two false teeth, or halfpennies—have been known to lodge near the base of the epiglottis and aryteno-epiglottidean folds for a very considerable time.

Such cases should be treated by laryngotomy to meet the urgent dyspnœa, and extraction of the bodies either by the finger, or appropriate forceps, or probangs.

(β) A small and light body—*e.g.*, a bead, a pea, or more likely an irregular one, as a bit of nutshell—may stick in the rima or ventricle of the larynx. If the first urgent symptoms pass off without operation,† the position of the body will be pointed to by the shortness of the intermissions between the attacks of spasm, and by the pain and the marked alteration of the voice.

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* I would refer my readers to some instructive remarks by Mr. Lund on the delusive impressions which may arise from the imagined swallowing of false teeth, &c. (*Hunt. Lect.*, 1885, p. 34).

† Occasionally, when the body is in the ventricle, the consequences may be very slight for a long time, especially if it is smooth and soon coated with mucus, and partly encapsuled. Mr. Durham (*Syst. Surg.*, vol. i. p. 760) mentions a case of Désault's, in which a patient, with a cherry-stone in one of the ventricles, refused operation and lived for two years, death then taking place from laryngeal disease.

The treatment, here, would be first to perform a high tracheotomy, and to dislodge the body from below with a female catheter or bougie of appropriate size, the cricoid cartilage being divided if needful.* If the body cannot be dislodged in this way, a partial or complete thyrotomy (p. 382) must be performed.

(γ) If the body pass through the larynx it will depend mainly on its outline and weight whether it remain in the trachea or pass into one of the bronchi. Thus, if it is light and smooth—*e.g.*, a cherry-stone—it may frequently shift its position, and then, from time to time rising into the larynx, cause spasm, and thus attacks of urgent dyspnœa, with paroxysmal cough and temporary aphonia.

In such cases tracheotomy should be performed with a free opening into the air tube, this being kept open by wire ligatures passed through the edges of the wound and tied behind the neck, or a dilator such as Mr. Golding Bird's may be inserted.

(δ) If the body is smooth and heavier it will probably fall into one of the bronchi. This subject is next dealt with separately.

FOREIGN BODIES IN THE BRONCHI.

Amongst these may be tracheotomy tubes,† especially ill-made ones, tubes worn too long, particularly if a low operation has been done (p. 389); pebbles; fruit stones; part of toy whistles; pieces of nutshells; &c. &c.

Site of Lodgment.—It has been shown by Mr. Goodall that owing to the septum being a little to the left and the right bronchus the larger, the foreign body usually lodges in this. According to M. Bourdillat's statistics,‡ out of 156 cases of impaction 80 were in the trachea, 35 in the larynx, 26 in the right bronchus, and 15 in the left. Out of 21 cases analysed by Prof. Gross (Durham, *Syst. of Surg.*, vol. i. p. 758), in which death took place without operation, and without expulsion of the foreign body, in 4 the foreign substance was situated in the larynx; in 1 partly in the trachea, partly in the larynx; in 3 in the trachea; in 1 in the right bronchial tube; in 1 in the lung; in 9 in the right pleural cavity. Out of 42 cases subjected to operation and general treatment, the extraneous substance was situated twice positively, and 11 times probably, in the right bronchial tube; 4 times certainly, and 4 times probably, in the left bronchial tube; 7 times in the trachea and 14 in the larynx. From these statistics it would appear that the trachea, larynx, and right bronchus are the most likely places in which a foreign body will be arrested.

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* In adults, attempts at removal with the laryngoscope and laryngeal forceps, aided by a 20 per cent. solution of cocaine, may be successful.

† Dr. Cohen (*Inter. Encycl. Surgery*, vol. v. p. 665) thus speaks of the frequency with which these bodies have slipped in when ill-made or corroded: "This source of the accident, so readily avoided by proper circumspection and admonition, is so inexcusable that I desire to emphasize the point with quite an array of references: Porter, *On the Larynx and Trachea*, p. 144; Gross, *Foreign Bodies in the Air Passages*, p. 325; Albert, *Arch. f. Clin. Chir.*, Bd. viii. S. 177; Waters, *Brit. Med. Journ.*, vol. i. 1868, p. 141; *Boston Med. and Surg. Journ.*, February 23, 1871; Buck, *Trans. New York Acad. Med.*, 1870; Pick, *Trans. Path. Soc.*, 1870, p. 416; Ogle, *Med. Times and Gaz.*, 1870, vol. ii. p. 531; Holthouse, *Lancet*, 1872, vol. i. p. 113; Ogle and Lee, *Lancet*, 1872, vol. i. p. 81; Hulke, *Lancet*, 1876, vol. ii. p. 785; Davy, *Brit. Med. Journ.*, 1876, vol. ii. p. 45; Burow, *Berl. Klin. Woch.*, No. 36, 1876; Thornton, *Tracheotomy*, p. 36; Howse, *Lancet*, April 17, 1877."

‡ Cohen (*loc. supra cit.*, p. 688). Dr. Cheadle and Mr. T. Smith reported (*Lancet*, Jan. 14, 1888) a case of occlusion of the left bronchus by a metal pencil-cap in a girl aged nine. Urgent dyspnœa followed at once, relieved by the passage

Evidence of a Foreign Body having lodged in a Bronchus.—Perhaps there may be a history of a foreign body in the mouth; pain dull, and heavy behind sternum, at about its junction with the second right costal cartilage;* shortness of breath, cough, expectoration; more or less diminution of breath sounds over a portion of the chest-wall;† râles; increased breath sounds on the opposite side; and, later on, evidence of inflammation and destruction of lung-tissue.

Treatment.—A low tracheotomy (p. 389) should be performed at once, and with as free an opening as possible. The edges of the incised trachea being held open with sutures of wire (not too

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of an œsophageal probang, the foreign body being believed to have entered the stomach. There was great pain at the time, and violent cough. By the eleventh day there was evidence of almost complete collapse of the left lung, this having commenced on the fourth day. There was no dyspnœa, but occasional short cough. The cap was believed to have lodged at the end of the left bronchus. Tracheotomy was performed through the thyroid isthmus, divided between two ligatures. The trachea was freely opened and its edges sutured to the skin. A long probe detected the cap, in the position diagnosed, with the open end uppermost. It was easily extracted with a pair of suitably curved forceps, with external grip. A good recovery followed.

* The division of the trachea is opposite the spine of the third, in some cases the fourth, dorsal vertebra. In front, this division is on the level of the junction of the first with the second bone of the sternum. The root of the spine of the scapula is on a level with the third intercostal space. A stethoscope placed here would cover the bronchi, more especially the right (Holden).

† "Obstruction of the left bronchus usually produces absence of respiration over the entire lung of that side, but occlusion of the right bronchus usually produces absence of respiration over the lower lobe of that side only, the division of the bronchus taking place much nearer the bifurcation, and the foreign body rarely lodging above the point of division" (Dr. Cohen, *loc. supra cit.*, p. 671).

fine), inversion and succussion should be tried, and a feather or probe used in order to excite cough.

If provided with suitable instruments (see below) the surgeon may at once proceed to attempts at extraction, but it is well to remember the fact pointed out by Mr. Durham (*loc. supra cit.*, pp. 769–770), that in a large proportion of the cases which have done well, expulsion has not been effected until some time after the operation.* Whenever a fit of coughing brings the body into view, the next inspiration will draw it back again, so that careful watching and prompt use of forceps, &c., will be required.

If from its shape, or from the interval which has elapsed, the body is too firmly impacted to be expelled by exciting coughing, the following instruments should be resorted to—viz., Gross's flexible German-silver tracheal forceps, long and slender and easily bent into any curve ; or Durham's forceps, equally flexible and giving a better grip.

Failing the above, stout silver or copper wire should be bent into the form of a blunt hook, or a long probe fashioned into the same shape.† The above instruments are first used as sounds and searchers, aided by the forefinger, which can be passed as far as the bifurcation of the trachea, and the orifice of each primary bronchus, as pointed out by Dr. Sands.‡

The operation should not be too prolonged, especially if the parts are inflamed : when this condition has subsided, spontaneous expulsion will often take place. Annandale§ recommends that this be promoted by the patient's taking a deep inspiration ; the surgeon then closes the tracheotomy wound till expiration, thus rendered more violent, follows and often drives out the body.

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* Thus, in a case of Dr. Smith's at Halifax (*Lancet*, 1876, vol. ii .p. 148), a boy, aged eight, swallowed a whistle (as thick as a penholder, and about ½ inch long) on January 8 ; it was not expelled till May 7, the child having, for the previous six weeks, had increasing cough and expectoration with progressive emaciation. The child recovered, and Dr. Smith draws attention to the fact that, owing to the very slight discomfort, it is doubtful if the cause would have been recognized if the impacted body had not produced a whistling sound, and thus demonstrated its presence.

† Mr. Hulke (*Lancet*, 1876, vol. ii. p. 785) used a long piece of German-silver wire, one end of which was bent into a blunt hook about ⅛ inch long, and the wire again bent about 1½ inch above this, at an angle roughly estimated as that which the right bronchus and trachea include. The other end was bent into a large loop, the plane of which coincided with that of the tracheal end of the wire beyond the angle, and thus allowed it to be guided into the right bronchus.

‡ *Amer. Clin. Lect.*, vol. ii. p. 199, Putnam, New York, 1876. Quoted by Mr. Durham, *loc. supra cit.*, p. 771.

§ *Med. Times and Gaz.*, February 27, 1875.

EXCISION OF THE LARYNX, PARTIAL AND COMPLETE (Figs. 92–94).

The value of these operations is still *sub judice*; much, therefore, of the following will require confirmation.

Indications.

(1) Sarcoma and carcinoma of the larynx, if intra-laryngeal.

The following questions must be answered when extirpation of the larynx is under consideration:—A. *Is the disease malignant?* B. *How far is it advanced?* C. *Is it intra- or extra-laryngeal?* D. *Which is the wisest operation to perform—excision or a palliative tracheotomy?* To give an answer here, (1) *the results of the operation*, and (2) *the after-condition of the patient* have to be duly weighed. E. *Does the general condition of the patient justify the operation?*

A. *Is the case one of malignant disease?*—A well-known case has lately drawn attention to the great difficulty of always diagnosing carcinoma. Dr. Semon has thus strongly drawn attention to this matter (*Trans. Intern. Med. Congr.*, 1881, vol. iii. p. 264). In answer to the objection that in the majority of the cases operated on the disease was already in too late a stage, Dr. Semon said: "Who, in a large proportion of these cases, will take upon himself to diagnosticate early and positively carcinoma? and who, again, if carcinoma is diagnosticated, will say positively whether it is in an early or more advanced stage? With regard to the first question, I wish to say that the differential diagnosis of carcinoma from tertiary syphilis, and its consequences, is often really not the easy thing one might be induced to believe from the convenient descriptions in the text-books. Not only is the laryngoscopic differential diagnosis often exceedingly difficult for a long time, but I wish to state here that it is necessary to be guarded in making the diagnosis and giving out the prognosis *ex juvantibus*; for, having had the opportunity of seeing and carefully observing an unusually large number of cases of laryngeal and œsophageal carcinoma in which I have given potassium iodide to avoid any possible error. I am able to state distinctly that in a large proportion of them the administration of this drug has produced a subjective improvement, and in some of them apparently even a temporary arrest of the progress of the disease, for a period varying from eight days to four weeks." The following points may help a decision in this most difficult and important matter. In cancer, pain is more constant, independently of use of the larynx; the cachexia is more definite, the glands are more likely to be involved (*vide infra*), and, perhaps, fœtor is more marked. As to appearance of the ulceration, Dr. Grant and Mr. Lennox Browne (*Arch. of Laryng., New York*, vol. ii., 1881) write: "The floor of a *tuberculous** ulcer is pale and granular, and slightly depressed; the margins fairly well marked, but not deeply excavated; the surrounding parts pale and languid, and there is an appearance of a spreading process of erosion very comparable to that of the nibbling of a small rodent animal. This is due to the confluence of small ulcers produced by the slow incurable inflammation of the mucous and closed follicles of the mucous membrane, and also to the ejection of minute tubercles which have worked their way to the surface. Very different from this is the punched-out, areolated excavation which is seen in *tertiary syphilis*, and which may be considered suggestive of a bite rather than of the continuous nibbling to which we have likened the tuberculous ulcer. Nor need we insist on the angry, hyperæmic, thickened walls of a *cancerous* ulceration, with its accompanying deformities and other signs, to still further point the laryngoscopic diagnosis."

B. *How far is the disease, if malignant, advanced?*—Dr. Semon (*loc. supra cit.*) with regard to the question, "Is it always possible to decide whether the carcinoma is in an early or advanced stage—*i.e.*, has or has not an infection of the neighbouring parts already taken place?" quotes the instructive case of a patient, aged sixty, who, having had syphilis twenty years before, began to suffer from his throat in October 1880. The diagnosis remained long doubtful between specific perichondritis and carcinoma, potassium iodide not yielding decisive results. It was not till early in March 1881 that the diagnosis of carcinoma could be actually established, and at this time the cervical lymphatics became slightly hardened, but not perceptibly enlarged. On March 9 tracheotomy was required, and *exactly one week after the operation* a swelling of the size of a hazel-nut, quickly increasing, appeared behind the right sterno-mastoid. Dr. Semon points out that if extirpation had been performed instead of tracheotomy there would have been a recurrence within one week of the operation.

The following remarks from a recent elaborate essay by the well-known Berlin laryngologist, Fränkel (*Deut. Med. Woch.*, Jan. and Feb. 1889; *Amer. Journ. Med. Sci.*, April 1889), will be found helpful:—

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* For a good instance of the difficulty in deciding between carcinoma and tubercle of the larynx, see *Brit. Med. Journ.*, 1888, vol. i. p. 609.

Stages of Laryngeal Carcinoma.—I. *Earlier Stages before Ulceration.*—The most frequent form is that of a tumour on one of the cords, appearing, in the commencement, as a flat, broadly sessile elevation. At first there is no other symptom than hoarseness, due, not to any immobility of the band, but to mechanical interference with the tonal qualities of the vocal membrane. The majority occur in men* over forty. Thus age, and sex, may be, to some extent, aids in the diagnosis. The carcinoma penetrates towards the interior of the tissues, instead of growing more into free space, as is the case with innocent growths. The epithelium becomes destroyed, and the surface then appears either flat or rugose, and greyish or whitish. This form is usually the keratoid or horny carcinoma. In preparing excised fragments for microscopical examination, great care must be taken to make the sections perpendicular to the surface, so as to avoid mistakes in their interpretation. In another class of cases the carcinoma of the vocal band is diffuse, tending to extend superficially instead of forming a circumscribed tumour. At first it can hardly be told from any other thickening of the mucous membrane. Almost invariably one band only is affected. Growth is slow. It may take a month for the thickening to exceed a few millimetres. Even when the entire band becomes involved, it preserves its contour and mobility. In keratoid carcinoma cornification is the prominent feature; in simple carcinoma, it is the papillary formation.† Impaired mobility of the cord has been noted by Fränkel only when the growth occupied the posterior part of the cord. In such cases median position of the cord soon took place. Polypoid and diffuse carcinoma occur in the ventricular bands and ary-epiglottic folds, the polypoid form being more dendritic than on the cord. Carcinoma of the posterior wall of the larynx soon causes impaired mobility of the cords, and, sometimes, early painful dysphagia. Early examination of excised portions is necessary, because involvement here soonest renders unilateral excision unavailing. Ventricular carcinoma probably often‡ begins in the numerous glands found here. Its diagnosis from inspection is very difficult, but prolonged observation eventually shows that the ventricular band and ary-epiglottic fold are not swollen, but are pushed outwards. Laryngoscopy offers no conclusion as to the nature of the tumour. Almost the only other tumour occurring in the ventricle is a gumma, the diagnosis being here usually practicable by treatment. Carcinoma of the cord has a great tendency to creep along the contiguous squamous epithelium and reach the opposite side. In this way the circular forms are produced. Carcinoma often extends much more deeply than is apparent on inspection. Carcinomas extending to the ventricular bands, the ary-epiglottic folds, and the epiglottis usually become dendritic or cauliflower-like in their further development. Laryngeal carcinoma takes sudden stages of recrudescence after intermitting intervals of apparent quiescence, and gradually produces stridor, which may proceed to asphyxia. Glandular swelling is less frequent, and occurs later than in the majority of other carcinomas. On the other hand, minute glandular swellings in the neck are difficult to feel. Cases also occur in which the glandular swelling is the most prominent symptom, and the only one in the absence of laryngoscopic examination. Thus it is difficult to estimate the value of enlarged lymphatic glands in the diagnosis of laryngeal carcinoma.*

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* M. Baratoux (*Progr. Méd.*, May, June, and July 1888) finds that of 301 cases of carcinoma, 265 were men; of 46 cases of sarcoma, 40 were also males.

† Epithelioma is much the most frequent variety—77 per cent. (Baratoux); of these, only three were cylindrical, all the rest squamous. Sarcoma occurred in about 7.5 per cent., the spindle-cell form being the most common.

‡ This view is scarcely supported by the very small number of cases of cylindrical epitheliomata; *vide supra.*

Later Stages.—Ulceration—Necrosis.—Despite the friction to which the parts are subjected, ulceration is a late manifestation, not taking place till the carcinoma has existed for a year at least. The ulcerations are usually recognised very readily by the laryngoscope. They are surrounded by tumid masses, sometimes smooth, sometimes with dense borders, sometimes covered with outgrowths papillomatous or granulation-like. When ulceration becomes more extensive, it may resemble that of syphilis or tubercle. When doubt exists, fragments of the tissues at the margin should be repeatedly excised for microscopic examination, although in many instances there may be no characteristic evidence detected. Sometimes microscopical examination of the sputum will help. Rapid disintegration gives rise to a peculiar fœtor, which sometimes proclaims the diagnosis. After a period, usually of several months, ulceration is followed by deep-seated mischief, especially necrosis of the cartilages, sloughing, and invasion of neighbouring structures. The carcinoma attacks the connective, elastic, and muscular tissues, and the glands. As to penetration of the cartilage, Fränkel finds that ossified cartilage is readily attacked, especially the thyroid, cricoid, and lower part of the arytenoids.* The disease grows uninterruptedly into reticular, but usually surrounds hyaline cartilage. The neighbouring healthy cartilage undergoes calcification. Additional necrosis of cartilage is produced by purulent perichondritis, a frequent complication. Extensive implication is found in marked contrast to the comparatively small crater-like ulcer on the surface. The perichondritis has nothing characteristic at first, but is usually recognizable by the co-existence of the growth, sometimes ulcerated, which has produced it. Perichondritis, especially when complicated with œdema, may produce sudden asphyxia, even when there has been no preceding stenosis.

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* Sappey (*Anat. Descript.*, t. ii. p. 861), quoted by Lennox Browne, *loc. supra cit.*, states that "in the upper orifice of the larynx the lymphatics are multiplied to infinity; inferiorly the mesh stretches over the corresponding wall of the vestibule of the larynx to the ventricular bands, becoming more and more attenuated."

C. *Is the disease intra- or extra-laryngeal?* †—It has been shown, by the remarks quoted from Fränkel, that laryngeal carcinoma, the squamous and horny epithelioma especially, is limited to the larynx for a considerable time. The opinion has been increasingly held of late that extirpation of the larynx should only be attempted while the disease is limited to that cavity, and not infiltrating adjacent structures and glands. Several cases have been recorded in which parts of the pharynx have been removed, in others portions of the œsophagus, trachea, and thyroid gland,‡ but the results are, with a few exceptions, far from encouraging, not only because a dangerous operation is rendered still more hazardous, but also because recurrence is usually rapid. Extirpation in extra-laryngeal cases is an operation where the surgeon may not know where to stop, owing to the extent of the disease. In deciding whether the disease is extra-laryngeal, the surgeon will be helped by observing whether the larynx moves in deglutition, and from side to side,* whether the glands are involved (*vide supra*, p. 413), by information gained by the finger passed from the mouth with the aid of cocaine, by the rate of the changes observed with the laryngoscope, and by the character of the growth from the first—*i.e.*, whether horny, flat, and sessile, or dendritic and papillary. Dr. Newman, in some most instructive lectures (*Brit. Med. Journ.*, 1886, vol. i. p. 816), writes: When the disease is intrinsic, "the prominent symptoms are aphonia and dyspnœa. The lymphatic glands are seldom affected; as a rule, cachexia is not a prominent feature during the earlier stages of the disease, and dysphagia is not a common symptom. In patients suffering from extrinsic† growths, on the other hand, aphonia is not usually present at the commencement of the disease, and, indeed, there may be only slight alterations in the voice; while dysphagia is, as a rule, present as soon as the growth has reached any considerable size. Pain in larynx and pharynx, extending round the neck and to the ear of the affected side, is more characteristic of extrinsic than of intrinsic new formations. In the former the glands are also involved at an early period, and cachexia is usually pronounced."

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* This opinion should be compared with that of Mr. Butlin, p. 427.

† In some cases this has only been decided during the operation, as in a case of Mr. Holmes (*Brit. Med. Journ.*, 1884, vol. ii. p. 809), in which, during the laryngectomy, part of the epithelioma was found to lie outside the larynx, extending upwards. In some cases the carcinoma is extrinsic from the first—*i.e.*, commencing in the pharynx, and involving the larynx by invading the epiglottis or aryteno-epiglottidean folds.

‡ Thus, Czerny, quoted by Dr. Newman (*loc. cit.*), in a case of lympho-sarcoma which had perforated the thyroid cartilage and involved the neighbouring glands, removed these latter repeatedly. The internal and external carotid, the internal jugular and the vagus were divided, and the patient died fifteen months after the primary operation. Gerster's case (p. 425) is an exceptional one, and it must be remembered—(*a*) that the growth was a sarcoma, (*b*) that the removal of the larynx was partial, and (*c*) that the last report was only carried up to a little more than half a year after the operation.

D. *Which is the wisest operation to perform for malignant disease—extirpation of the larynx or a palliative tracheotomy?*—Here we have to consider—(*a*) *the results of the operation*, (β) *the after-condition of the patient.*

(*a*) With regard to the results of the operation, I may, I think, fairly take the statistics of Dr. Hahn, of Berlin,‡ whose wide experience and special opportunities in this branch of surgery are well known. They appear to me to be even more discouraging than the earlier ones, taken from many operators, which he collected previously (*Volkmann's Vorträge*, 1885), and which have been most carefully examined by Mr. Butlin (*Oper. Surg. Mal. Dis.*, p. 192). The cases are divided into three groups—(A) ***Extirpation of Tumours from the Interior of the Larynx;*** (B) ***Unilateral Resection of the Larynx;*** (C) ***Total Extirpation of the Larynx.***

(A) ***Extirpation of Tumours from the Interior of the***

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* It is noteworthy that the larynx may be movable, and yet the pharynx be implicated, as in a case reported by Surgeon-Major McLeod (*Lancet*, April 26, 1884).

† *I.e.*, creeping in from the pharynx.

‡ A translation of his manuscript will be found in the *Journal for Laryngology and Rhinology*, May 1888. Carcinoma laryngis is the only term used for malignant disease.

Larynx.—By this is meant opening the larynx ("laryngo-fissure") and scraping it out, with sometimes application of the cautery or partial excision of the cartilages. Of the three cases, one died on the eleventh day, from heart failure and pulmonary thrombosis, the patient, an unfavourable one, having urgently requested the operation. In the other two recurrence took place, one unhappy patient hanging himself.

(B) ***Unilateral Resection of the Larynx.***—Of six cases, two died from the operation; of the four recoveries, recurrence took place in one; of the three others, it is stated that one remained free from recurrence a few months after the operation, and that the two others were discharged cured, one with slight indication of necrosis.*

(C) ***Total Extirpation of the Larynx.***—Of six cases, only one survived the operation and remained free from recurrence, this case being a brilliant triumph *as far as it goes*, over seven years having elapsed since the operation. When we remember that these are the results of a man who has had special opportunities, perhaps unequalled save by those of Billroth, and who has been working at the subject for eight years, the outlook of the operation appears to me to be extremely gloomy.

(β) *The After-condition of the Patient.*—This is a most important matter, and one which should be fully explained to the patient. The amount of comfort will mainly depend upon two things—(1) whether half or the whole of the larynx has been removed; (2) whether much of the skin and soft parts has had to be taken away, or has sloughed.

With regard to the first point, if only half of the larynx have been removed, the patient usually swallows early and easily, and speaks quietly and hoarsely, but with very fair distinctness, and without any need of mechanical aid. Where the whole larynx has been taken away, some such appliance as that of Gussenbauer's will be required to enable the patient to make himself understood. Much difficulty is often present in these cases in keeping open the upper part of the wound for the introduction of the artificial larynx. Even after complete removal, if the pharynx has been left untouched, the power of swallowing will be but little impaired. If, however, the surrounding soft parts have had to be widely extirpated, so large a gap will be left that swallowing will be impossible, and it will be necessary to feed the patient with a tube.

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* A most successful case by this operator on a well-known English barrister is recorded by Dr. Semon, *Clin. Soc. Trans.*, vol. xx. p. 44.

While, for the present, it must remain uncertain how far the after-condition of the patient will be better than that foretold after the earlier laryngectomies,* there is no doubt that when the soft parts in front of the pharynx have had to be extensively removed, the after-condition is one of great discomfort.†

E. *Does the general condition of the patient justify the operation?*—The age of the patient (not only to be recognized by years), his power of meeting, and of recovery after a very severe operation, the presence of any liability to bronchitis, broncho-pneumonia, asthma, his capability of assimilating food, the condition of his viscera—*e.g.*, kidneys and liver—have all to be most carefully considered, in addition to such local points as the size of the growth; its nature, whether squamous and horny epithelioma or dendritic, papillary, and encephaloid; its rate of growth; the duration of any ulceration, whether it is intrinsic or extrinsic.

The *conclusions* to be drawn from the above are, I think, (1) That the operation is justifiable in the sarcomata owing to their smaller liability to infect the glands, and the younger age of the patients, and, therefore, their *à priori* better condition; (2) that it should be abandoned in carcinoma, save in the earlier stages, while the growth is distinctly unilateral, and the patient, having had all the risks fairly put before him, decides to undergo the operation. In such early stages it is probable, though more cases are required to decide the matter, that the modified laryngectomy which Mr. Butlin (p. 427) has so strongly recommended and successfully practised will be found sufficient. But these early operations will introduce questions very difficult of answer. (α) It has been shown above (p. 410) how very difficult it is for even skilled laryngologists to bind themselves to a decisive answer early in the case, and to all that may come of it. (β) Then it must never be forgotten that removal of the larynx is an operation of great severity, liable to entail a condition of shock (especially in patients well on in life) quite out of proportion to the size of the part removed. (γ) Furthermore, this operation, especially its severer forms, apart from the question of recurrence, has special risks of its own—*e.g.*, septic cellulitis and broncho-pneumonia—and thus an early operation may, if fatal, shorten a life materially.* (δ) Statistics are in such a case especially unreliable. Thus, while all the successful operations are probably published, many of these have been insufficiently followed up, while, on the other hand, it is highly probable that many unsuccessful cases have never been brought forward.

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* Thus, Sir M. Mackenzie at the International Medical Congress, 1881 (*Trans.*, p. 263), stated that "the condition of a patient after extirpation of the larynx is usually one of great misery." Dr. Cohen, of Philadelphia, holding the same view, drew attention to the importance of distinguishing between "recovery" and mere "survival" after the operation.

† A good illustration of this condition and an idea of its results are given by Dr. Cohen from Lange, fig. 1095 (*Inter. Encycl. of Surg.*, vol. v. p. 776). He also points out that too early attempts to use an artificial larynx only cause hæmorrhage, while an apparatus which is adjustable at first, is often rendered useless by further cicatrisation.

A palliative tracheotomy, as soon as dyspnœa sets in, will be the wisest course in all cases unsuited to excision—*e.g.*, advanced or extrinsic ones—where this operation is refused, and in cases where the surgeon is in doubt. As the average duration of life in epithelioma here is from 2 to 2½ years, the time still remaining after tracheotomy may be from 1 to 1½ year. The fact must be in no way kept back or made light of that the closing months will be a time of much misery.† It will be wise to prepare the friends for this at the time when the question of operative interference, with all its risks and uncertainty, is discussed.

(2) A few cases may arise in which there is no malignant disease, but the laryngeal cavity is destroyed, and is a constant source of discomfort and danger. Thus, in Dr. P. Heron Watson's case,‡ a gentleman aged thirty-six, palliative tracheotomy had been performed to relieve the ulceration of tertiary syphilis. The larynx healed, but the puckering gave rise to a condition of matters by which some portion of all fluid nutriment and saliva made its way into the trachea and occasioned fits of spasmodic cough. Feeding by the tube did not prevent the saliva from passing down, and, in almost every instance, on its withdrawal some fluid regurgitated, and some part of it passed into the trachea, &c. The patient rallied from the operation for removal of the larynx, but died some weeks afterwards from pneumonia.

Both in this case and one in which Rubio, of Madrid, removed the larynx for necrosis of the cartilages in a man aged forty-one, with a fatal result on the fifth day, there was great debility before the operation. With regard to this group of cases, Dr. Foulis remarked, "When the breathing and voice are impeded, and the parts are no longer capable of distension by dilatation, it appears to me that the diseased larynx may be properly removed and replaced by an artificial one."

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* After laryngectomy for carcinoma about two-thirds of the cases die within six months of the operation. In 21 per cent. of the whole number of extirpations death takes place during the first fortnight after the operation, from respiratory complications (Schwartz).

† In a few cases, as in one which Mr. H. Morris brought before the Clinical Society (*Trans.*, vol. xx.; *Brit. Med. Journ.*, 1886, vol. ii. p. 975), removal of the larynx may be called for after a palliative tracheotomy has been done; but owing to the downward extension of the growth, the tracheotomy-tube becomes a source of continual irritation and distress, though absolutely necessary for respiration, and the suffocative cough and dyspnœa cannot be relieved by other means. The case is alluded to again p. 430. The patient, a man of fifty-nine, sank on the eighth day, from exhaustion.

‡ Quoted by Dr. Foulis, *Trans. Internat. Med. Congr.*, 1881, vol. iii. p. 251.

(3) It is just possible that excision of the larynx may, in the future, be performed as part of an operation for removal of a thyroid gland the site of malignant disease. It is well known how fatal removal of the thyroid gland often is in these cases from interference with the recurrent laryngeal, injury to which is often unavoidable. It has been suggested* that, in these cases, if it will facilitate extirpation of the malignant disease, or if there is reason to think that the above nerve has been injured, the larynx be removed, thus not only giving more room for dealing with the original disease. but also for removing a fertile source of dyspnœa and spasm. But considering the age and general condition of these patients, it is very doubtful if this suggestion will bear fruit.

Operation.

Preliminary Tracheotomy.—This should be done a week at least before the operation for excision. The advantages are that: (1) The patient gets used to breathing through an artificial apparatus. (2) The easier breathing will improve his general health. (3) The lungs, being less engorged after thus receiving air freely, will be less likely to become the seat of bronchopneumonia. (4) When tracheotomy is performed less time will be taken up by the operation, and no blood will enter from this source. (5) The trachea will have become adherent to the skin, and thus tends less to fall away when the larynx is severed from it, so preventing diffusion of pus.

With regard to the site of the tracheotomy, it should be low rather than high, for, if done high up, (1) it may be too near the seat of the disease, and (2), a more important point, if a high operation is performed, the lower end of the excision-wound will come into parts infiltrated and altered, and thus difficult to distinguish at a very critical stage of the operation.[*]

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* Dr. Foulis (*loc. supra cit.*, p. 258) quotes briefly a case of Dr. Bircher's, in which a scirrhous thyroid had been excised; six months later recurrence took place, and the larynx was excised with part of the gullet. Death took place in ten days from pneumonia and gangrene of the lung. Prof. Caselli (*Inter. Med. Congr.*, 1881, vol. iii. p. 262) stated that he had performed partial excision of the larynx in the case of an enormous myxo-fibro-chondroma of the hyoid and larynx, the patient, who was much exhausted, dying in three days.

While the above is believed to be the wiser course, some have had good results with a high operation, performed before or at the same time as the removal of the larynx. Thus Mr. Lennox Browne (*loc. infra cit.*), having performed a high tracheotomy (between the second and third rings), introduced Hahn's tampon-cannula, consisting of a tube surrounded with compressed sponge.[†] Other operators have dispensed with tracheotomy altogether.

The patient is brought under the influence of an anæsthetic (the A.C.E. mixture, chloroform or bichloride of methylene being the best), given, if possible, through the tracheotomy tube or tampon-cannula by tubing, which keeps the surgeon and the administrator out of each other's way. The surgeon must decide whether he will perform the operation with the patient in the usual position, cutting from above downwards, or with the head supported in the dependent position, pillows being placed under the dorsal spine, the incision being now made from below upwards.[‡]

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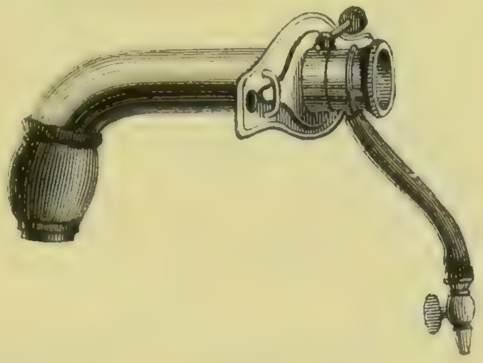
[*] On this account Gussenbauer prefers a high tracheotomy with horizontal severance of the trachea as the initial step in laryngectomy, owing to the fact that after a preliminary tracheotomy the tissues become so infiltrated and matted that they are less readily recognized, and also complicate the detachment of the soft parts and make hæmorrhage more serious. On this point Mr. Butlin's argument, that in patients exhausted by long-continued dyspnœa there can be no question that it is essential to success that tracheotomy should be performed some time previous to the operation, will carry great weight with most surgeons.

[†] Cannulæ with air or water tampons are liable to the serious drawback of sudden rupture. On this account it seems best to use ordinary cannulæ surrounded with aseptic sponge. Mr. Butlin prefers the tube recommended by Hahn for these reasons:—(1) It consists of an inner and an outer tube, the inner of which is the longer, projecting about 1½ inch in front of the shield so as to render the entrance of blood very unlikely. In order to prevent this projection inconveniencing the operator, it is made to bend down parallel with the trachea before it stands out at a right angle with the neck. (2) The outer tube is partly covered with a layer of compressed sponge, previously soaked in iodoform and ether (1 in 7). The sponge is fastened on by sutures and by silk tied round its upper and lower end. (3) About ten minutes after the introduction of the tube the sponge swells up from the absorption of moisture, and the entrance of liquids into the trachea is thus prevented. This arrangement of sponge seems to hold the tube more steadily in position than the india-rubber bag of Trendelenberg's tampon, which is liable to become slippery, and which, moreover, may burst during the operation. The tube and the way to use it are described by Dr. Semon (*Clin. Soc. Trans.*, vol. xx. p. 47).

[‡] Dr. Cohen (*loc. infra cit.*) thus states the chief merits of the two methods:—"Removal from above downwards is the more tedious. To some operators it appears to be the safer plan, inasmuch as it effectively avoids all risk of escape of blood and other matters into the tracheal extremity of a severed windpipe

The former course, if the tampon to be used is a reliable one, is probably the best, the tampon-cannula of Trendelenberg, Dr. Semon's modification of this (Fig. 91), or Dr. Hahn's tampon being introduced instead of the ordinary cannula. If no tracheotomy is performed either some time previously or immediately before the operation, the median incision being made, the trachea is usually first isolated and divided, and then a large tube or tampon-cannula inserted.

FIG. 91.



Dr. Semon's modification of Trendelenberg's tampon-cannula.* (Mackenzie.)

If the operation is begun from above, an incision is first made from the lower border of the hyoid bone exactly in the middle line, vertically down to the level of the first or second ring of the trachea, and a second at right angles to the first, either at the level of the hyoid bone or across the thyroid cartilage, in either case passing outwards to the sterno-mastoids. The vertical incision should go down to

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during the important stages of the dissection, for the severance of the larynx from the trachea is the last step of the procedure instead of the first, and may be delayed until all hæmorrhage is under control. The opposite plan is said to possess the advantage that, the trachea being taken care of in the first instance, the operator can proceed more rapidly, and be relieved from all anxiety as to the entrance of blood into the air-passages." The surgeon is also enabled to work away from the anæsthetic and the hands of the administrator.

* This instrument is thus described by Sir M. Mackenzie (*Dis. of the Throat and Nose*, vol. i. p. 516, fig. 107, from which the above illustration is taken): "It consists of an ordinary tracheotomy tube, with a broad groove running round its lower extremity externally. This groove receives a hollow india-rubber air-belt, which, when uninflated, is flush with the surface of the cannula. A fine capillary silver tube, soldered inside the cannula, communicates at one end with the air-belt, and, at the other, opens near the anterior orifice of the cannula. To this extremity is attached a piece of elastic tubing about 6 inches in length, with a stop-cock at its free end. The cannula having been introduced into the trachea, the belt is inflated by means of the tube, and the stop-cock turned off. The expansion of the belt blocks up the space between the cannula and the walls of the trachea, and thus renders it impossible for any blood to pass from the larynx into the air-passages. It is very important not to fill the air-belt too full, as much pressure suddenly applied to the trachea is apt to produce an asthmatic paroxysm." Another risk, that of bursting the belt, is alluded to elsewhere. In Trendelenberg's original instrument the capillary tube was placed outside the cannula, and rendered the latter very difficult of introduction. If possible, all tampon-cannulæ should be dispensed with. It is very difficult in practice to secure the right degree of distension. If the tampon be distended sufficiently to plug the trachea, it is often not tolerated by the patient; if it be reduced in size, blood finds its way between it and the trachea.

the thyroid and cricoid cartilages and trachea. The soft parts over the thyroid and cricoid are then raised *en masse* by inserting a blunt dissector or raspatory so close to the cartilages that the perichondrium itself is lifted up with its relation to the soft parts over it undisturbed. This separation is carried back as far as the middle of the junction of larynx and pharynx, the thyroid and cricoid cartilages carefully severed in the middle line with stout scissors or cutting-forceps, the two halves separated with retractors, and the interior examined to see if partial removal of the larynx will be sufficient.

The above method of working very close to the cartilages with a blunt instrument only was first used by Mr. Browne at the suggestion of Mr. Henry Morris; it has the conspicuous advantages of disturbing but little the soft parts and of causing but trifling hæmorrhage.* The transverse incision was not found necessary in this, a unilateral removal of the larynx.

Where the parts do not admit of the above step, or where the parts outside—*e.g.*, glands—are found involved, flaps of skin and fascia are reflected, and the larynx exposed as freely as possible, any enlarged glands now seen should be removed, and the crico-thyroid arteries secured. The sterno-hyoids, sterno-thyroids, and thyro-hyoids are next peeled off from the thyroid cartilage with a blunt dissector, or ligatured with chromic gut and cut through (the knife being kept close to the cartilage), and the lateral lobes of the thyroid gland carefully separated in the same way, ligatures being tied at their junction with the isthmus, if needful. The soft parts at the sides which contain the large vessels, &c., are now carefully retracted, and, the larynx being drawn first to one side and then to the other, the constrictors are divided very close to their attachments to the cricoid and thyroid cartilages. The superior laryngeal vessels are next secured and divided as they enter the thyro-hyoid membrane.†

Up to this point very little blood, if any, has entered the air-passage, and, if the growth have not caused obstruction, the inflation of the tampon may be left to this stage. If the surgeon be unprovided with one of these, or if the one in use do not work satisfactorily, the larynx had best next be detached from the trachea, the cricoid, or a small circle of this, being left if possible to give support later on for the artificial larynx.* If, however, there is any doubt as to the extent of the growth downwards, the division had better be made between the rings of the trachea itself. The lower end of the trachea is next to be carefully stitched to the skin, or held forwards by sutures not yet tied, and a large tube of vulcanite, lead, &c., a full-sized tracheotomy tube or Macewen's tracheal tube, each being made sufficiently bulky by compressed gauge or drainage tube, is put in to prevent blood, &c., descending; for this purpose the end of the tube must be closed.

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* In thus raising the soft parts, by keeping close to the cartilages of the larynx, care should be taken not to separate needlessly the soft parts from the trachea. Some of these—*e.g.*, the lateral masses of the thyroid gland, which are now also detached with a blunt dissector—are useful in preventing descent of the trachea.

† Mr. Butlin, quoting from Hahn, advises that, in detaching the soft parts at the back of the larynx, blunt-pointed scissors should be used with a series o short snips.

The removal of the larynx is next carried on from below upwards, especial care being taken, in the separation of the œsophagus from its connections to the trachea and larynx, not to button-hole it (Foulis), especially at its attachment to the cricoid. During this stage the larynx is kept dragged forwards with vulsellum-forceps or a sharp hook.

If, as the dissection is carried upwards, the laryngo-pharyngeal junction is found to be infiltrated, the anterior and lateral walls of the pharynx must be removed as well. If the surgeon decide now to remove the epiglottis,† the knife must be carried upwards through the thyro-hyoid ligament, so as to pass between the tongue and epiglottis, its course being controlled by the left forefinger passed into the mouth. If the epiglottis is left, the knife is carried through the thyro-hyoid membrane and the thyro-epiglottic ligaments as well.

As soon as the larynx is removed, attention should be paid to any bleeding points,‡ and the cut trachea and edges of the pharynx (if this has been partly removed) stitched most carefully with carbolized silk sutures to the edges of the skin wound, if this has not been already done in the case of the trachea; secure union being of the utmost importance to prevent burrowing in the cellular tissue of the neck.

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[*] Hahn, however, removes the cricoid cartilage in complete extirpation of the larynx, as he thinks that, if left, it interferes with deglutition.

[†] "The weight of testimony seems to indicate the propriety of sacriificng the epiglottis in all cases of carcinoma, and in all others in which an artificial larynx is to be used" (Cohen).

[‡] Numerous Spencer-Wells' forceps and chromic gut ligatures should be at hand, oozing being checked by very hot sponges, wrung out of a mercury bi-chloride solution 1 in 2000. The wound should be carefully irrigated with the same solution at intervals from first to last, and a little iodoform insufflated.

PARTIAL REMOVAL OF THE LARYNX (Figs. 92, 93, 94).

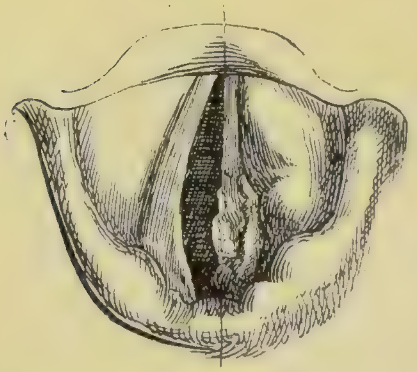
As it is quite unsettled which operation will, in a larger number of cases, give the best results, the following three will be given here—viz., (A) Removal of half the larynx; (B) Modified laryngectomy; (C) Thyrotomy and removal of the diseased parts.

(A) *Unilateral extirpation of the larynx* may be made use of when, after exposing it, partially freeing it from surrounding soft parts, and slitting it open, it is found that the disease is limited to one side.

Dr. Newman (*loc. supra cit.*) gives the following as indications:—(1) Malignant disease of limited extent; (2) Stenosis or obliteration of larynx which cannot be cured by other means; (3) Recurrent papillomata not removable by less heroic interference.

The advantages of partial removal at present seem undoubted. (1) The mortality, 33 per cent. after total extirpation, is only 20 per cent. after unilateral;† (2) The dangers of recurrence are not greater if cases are properly selected;‡ (3) The voice may be almost perfectly retained without use of the tracheal cannula; (4) Deglutition is completely preserved.

FIG. 92.*



Epithelioma of the left cord. From a patient in whom Mr. Lennox Browne successfully removed half the larynx.

Mr. Lennox Browne (*loc. supra cit.*), in his case of removal of half of the larynx (Figs. 92, 93, 94), having exposed it by subperichondrial raising of the soft parts, divided the thyroid cartilage with cutting-forceps, removed the half by (*a*) Thorough separation of the attachments to the pharynx with the raspatory aided by the knife-handle and finger-nail; (*b*) Division of the thyro-hyoid membrane as close as possible to its thyroid attachment; (*c*) Division of the left superior horn of the thyroid cartilage at its root by cutting-pliers; (*d*) Division in the middle line of the cricoid cartilage, in front and behind; (*e*) The divided half of the larynx was then separated from the first ring of the trachea, and a few nicks only were necessary to remove it entire. The very slight oozing * which ensued after the removal of the diseased part was checked by a slight application of the galvano-cautery, which would also destroy any possible fragments of diseased tissues not removed. The left aryteno-epiglottic fold was divided close to the cartilage of Wrisberg, and the thyro-hyoid membrane close to its thyroid attachment, with the view of impairing as little as possible the action of the epiglottis. The success of this plan was completely shown by the ease with which deglutition was effected three days later.

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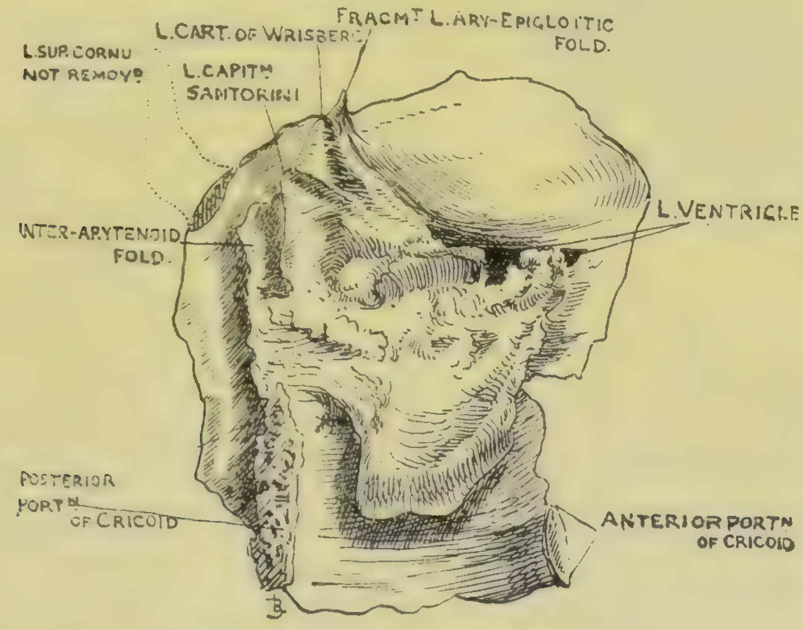
* I am indebted to Mr. Lennox Browne for permission to make use of this and the next two illustrations. They will be found in his paper (*Brit. Med. Journ.*, February 5, 1887) and in the second edition of his book on the *Throat and its Diseases*, p. 457.

† Mr. Lennox Browne (*loc. infra cit.*) states that some thirteen or fourteen cases have now been recorded, and that in only one instance has there been an immediately fatal result.

‡ Drs. Hahn and Schede (*Germ. Surg. Congr.*, April 1884; *Lond. Med. Record*, 1884, p. 358) showed that (1) this operation was much less severe; (2) relapse was not more frequent; (3) impairment of function was much less. In one of Schede's cases the patient was a dentist; he could, after a while, dispense with any cannula and follow his calling, his speech not attracting notice. As a result of cicatricial contraction, a prominent fold of mucous membrane had formed, immovable, but capable of performing many of the functions of the right cord, the left moving up to it, and thus forming a rima glottidis. In the case of a well-known barrister, operated on by Dr. Hahn, and brought by Dr. Semon before the Clinical Society (*Trans.*, vol. xx. p. 44; *Brit. Med. Journ.*, 1886, vol. ii. p. 975), the patient recovered so well that he was able to fill the position of police magistrate.

FIG. 93.



Inner aspect of the portion removed.

Dr. Gerster, of New York (*Ann. of Surg.*, Jan. 1886), reports a successful case of unilateral extirpation of the larynx for sarcoma, in a patient, *æt.* 57. The laryngoscope showed a smooth pale tumour of the size and shape of an almond, commencing in the left glosso-epiglottidean fold, extending through the substance of the left vocal cord into the ary-epiglottidean fold, and ending in the arytenoid cartilage.

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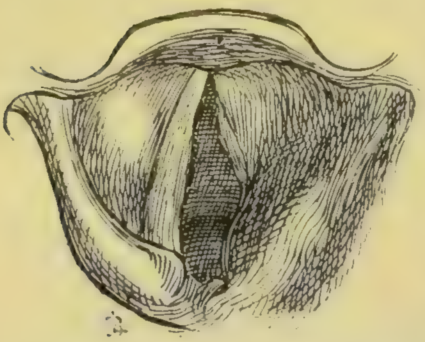
* Only two small vessels required torsion, a happy result, due to the use of the raspatory, and to keeping so close to the cartilage.

A preliminary low tracheotomy was performed, and at the same time a deep-seated, hard, glandular swelling of the size of a hen's egg was removed from the left sub-maxillary region, together with part of the internal jugular and the sterno-mastoid.

FIG. 94.



Laryngoscopic view from the same patient four months after operation.

About six weeks later the left half of the larynx was thus removed. A tampon-cannula was inserted and distended in the tracheotomy wound; after this an incision—commencing at the upper notch of the thyroid, and extending to the lower margin of the cricoid cartilage—laid bare the larynx in the middle line. To this was added another cut, commencing in the upper angle of the first, and extending horizontally to the anterior margin of the left sterno-mastoid. The crico-thyroid ligament was split to admit a strong pair of bone-pliers for the division of the thyroid cartilage, but it was found impossible to perform this act, as the strongly inclined position of the cartilage did not permit an effective handling of the instrument. Therefore, access was gained by an incision through the thyro-hyoid ligament, and an exact division of the calcified cartilage thus effected. After this the epiglottis was cut through lengthwise, the left half of the crico-thyroid ligament divided, and the superior thyroid artery included in a double ligature and cut through. The most difficult part of the operation consisted in the dissection of the lateral portions of larynx and pharynx, closely adherent to the carotid artery by cicatricial tissue, caused by the previous extirpation of the glands. Shallow incisions, running parallel with the course of the artery, were cautiously made, and the difficult task seemed almost completed, when suddenly a powerful jet of arterial blood welled up from the bottom of the wound. The bleeding point was easily secured, and then it was ascertained that the trunk of the superior thyroid (doubly ligatured further below prior to this) had been cut away level with its origin from the carotid. Two catgut ligatures were applied around the main trunk above and below the forceps, and when the instrument was removed a round hole in the side of the carotid became visible. The remaining adhesions, corresponding to the left lateral portion of the pharynx, could now be easily dissected out. The patient made a good recovery, but a plastic operation was required to close the wound, and about seven weeks after the operation a small suspicious glandular swelling was removed from the supra-clavicular region. Five months later the general condition was remarkably improved. Swallowing of solids and semi-solids was excellent; drinking had to be slowly and carefully done. The patient could speak with a hoarse whisper, readily understood at a distance of 10 or 15 feet. The cicatrices were soft and normal. The laryngoscope showed a smooth, rather extensive, scar occupying the left side of the pharynx and larynx. The right cord was normal. Two other most interesting cases of partial extirpation of the larynx are recorded by Dr. Semon (Dr. Hahn being the operator) and Mr. Butlin (*Clin. Soc. Trans.*, vol. xx.).

(B) *Modified Laryngectomy.*—Mr. Butlin in this country (*vide infra*), and in America Dr. Solis Cohen, have drawn attention to the infrequency with which the thyroid cartilages are invaded by malignant disease. Dr. G. Fowler has, accordingly, thus further modified the operation. In a woman *æt.* 58, the subject of hoarseness for two or three years, which five months before the operation amounted to complete aphonia, a growth (subsequently proved to be epithelioma) was found on the left cord. On November 17, 1888, four days after a preliminary low tracheotomy, an incision was made from the hyoid bone to the first tracheal ring. The soft parts were separated (the thyroid isthmus being divided with the thermo-cautery) and retracted on either side, and, all hæmorrhage being stopped, the cricoid was separated from the first tracheal ring. The stump of the trachea was packed with gauze, and kept well drawn forward with a silk ligature. Each wing of the thyroid being split about ¼ inch on either side of the angle of junction, "the interior structures of the larynx were now cleared from the inner surface of the thyroid cartilage; the mucous membrane of the right side peeled off easily, but that on the left proved to be hard and somewhat unyielding, although it finally separated completely from the underlying thyroid. Both wings of the cartilage being cleared, the soft parts behind and at the sides of the cricoid, including the articulation of the latter with the inferior cornua of the thyroid, and its connection with the œsophagus, were separated; the attachment of the inferior constrictor to the posterior portion of the thyroid was not interfered with. The arytenoid cartilages were included in the parts thus dissected. Upon reaching the line of the attachment of the œsophagus to the cricoid posteriorly, the former was opened in the median line, and through the opening thus formed the left index was passed into the pharynx up to the base of the tongue and hooked over the epiglottis. The latter, together with the entire respiratory contingent, were now drawn forcibly downward, so as to identify the attachments of the thyro-hyoid membrane. The latter was now incised, and the epiglottis detached from the aryteno-epiglottidean folds, when a few touches of the knife served to release the whole mass. It was found that the entire diseased mass had come away completely."

(C) *Thyrotomy and Removal of the Diseased Parts.*—Mr. Butlin (*Oper. Surg. Mal. Dis.*, p. 191) is in favour of thus limiting the operation. "When the disease is of very small extent, limited to the true and false cords of one side, not extending into the structures above and below, not even adherent to the cartilage, I believe the better course to pursue will be to remove the diseased structures and a wide area of the surrounding soft tissues, just in the same manner as one treats an epithelioma of the lip, without insisting on the removal of even one-half of the thyroid cartilage. Cartilage, whether calcified or not, is peculiarly resistant to the progress of cancer, and when the disease appears to be adherent to it, it is the perichondrium which is affected, and only in the rarest instances the cartilage itself. Cancer of the larynx far more often causes the death of the cartilage piece by piece, than infiltrates it." While the above remarks, coming as they do from one who is distinguished for his knowledge of malignant disease, and for being one of the few English surgeons who have successfully extirpated half the larynx, are entitled to every respect, more cases are required before it is seen how far this very limited proceeding is justifiable in malignant disease. Mr. Butlin has on two occasions practised what he taught. Thus he relates (*Clin. Soc. Trans.*, vol. xxii. p. 94) two cases of epithelioma (one in a woman aged twenty-seven) in which he successfully removed the disease without taking away the framework of the larynx. "Tracheotomy was performed, the first four tracheal rings were divided, and Hahn's tube was introduced. At the end of twelve minutes, when the sponge was sufficiently swollen to plug the trachea (p. 420), the thyroid and cricoid were divided, and the two sides held widely apart with blunt hooks. The exposure of the growth was excellent. The disease was much more extensive than had been suspected; it occupied the commissure, the margins and under-surfaces of both vocal cords, and the subglottic region, and penetrated deeply into the subjacent tissues, reaching in two places down to the cartilage, but not eating into its substance. I cut it out very freely with scissors, then scraped the edges of the wound with a Volkmann's sharp spoon, laying the cartilage quite bare. The larynx was left open, dusted with iodoform, and plugged with iodoform gauze. On the following day, Hahn's tube was replaced by a large silver tracheotomy tube wrapped round with iodoform gauze." The patient was fed by an india-rubber tube. Ten days later, the sides of the larynx being held apart, Vienna paste was applied to the former seat of the cancer; this produced some temporary irritation, which soon subsided, but Mr. Butlin doubts whether any good was effected, owing to the difficulty of keeping the parts free from mucus and saliva. Three weeks after the operation the tracheotomy tube was removed. In the other patient a similar operation was performed, but the cricoid was not divided; "the exposure was as good as could have been desired." The Hahn's tube was removed the day after the operation, but not replaced by another tube. The first case, operated on November 1887, is reported up to May 1889, and showed no sign of recurrence. The second is equally satisfactory as far as it goes, the operation having been in July 1888, and the patient free from any sign of recurrence when last seen in January 1889. The chief explanation of this very happy result is the fact that the disease in each case was of very limited extent. Thus, in the first case there was "a warty growth of pale-red colour almost at the commissure and apparently projecting from the margin and upper aspect of the right cord." In the second case, upon the free border of the right cord "at the junction of the posterior with the two anterior thirds, was a prominent growth, granular, rounded, but flattened on the aspect which looked towards the other cord." The first patient was able to speak in a hoarse voice, the second in a hoarse whisper. Microscopical examination of fragments previously removed * had proved the existence of epithelioma.

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* It is noteworthy that, in the next paper to Mr. Butlin's, Dr. Newman sounds the following note of warning as to a possible result of intra-laryngeal removal of bits of growth for examination. "While, on the one hand, intra-laryngeal excision for microscopic purposes clears up the diagnosis in carcinoma, it also exposes the patient to very serious dangers by increasing the rapidity of secondary new formations. The incision of a cancerous growth, or its partial removal, has justly been regarded as a most dangerous procedure, probably because the absorption of the infective material takes place rapidly from a wounded surface. For instance, judging from my experience of other similar

After-Treatment.—All hæmorrhage being arrested, the wound is brushed over with a 10 per cent. zinc-chloride solution, or iodoform and ether, and dusted with iodoform; one or two sutures may be placed at the ends of the transverse incision, but the vertical incision should be left widely open for drainage, the wound being lightly packed with strips of iodoform or sal-alembroth gauze. These should not be changed too frequently, and, at each renewal of the dressings, the wound should be irrigated with some antiseptic solution and carefully cleansed with camel's-hair brushes. Thiersch, to prevent lung infection, keeps the head low for the first few days. The trachea should be kept well plugged. Mr. Butlin advises that an ordinary tracheotomy tube covered with iodoform gauze be substituted for the compressed sponge-tube at the end of twenty-four hours. The gauze should be sufficiently thick to stop any discharges getting into the trachea, and should be changed once a day. It is very important to keep the wound sweet and clean to prevent the pneumonia which has so frequently proved fatal after excision. The inspired air should be charged with antiseptic vapours. Nourishment must be supplied, for the first week, by a soft tube* passed either by the nose or mouth, and, if it is desirable to retain this, it would be well to make trial of this method before the operation. Feeding by enemata alone is not reliable, considering the debilitated condition of these patients, and the profound shock which often accompanies this most serious operation.

The temperature of the room must be from 65° to 70°. A moist carbolized sponge or layer of gauze should be kept in front of the tracheotomy tube. When the wound has become firm, the

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cases, I should say that neither in case 2 nor 3 would the lymphatic glands have become involved for months had I not removed portions of the growth with forceps. In both instances the tumour was limited in size, and in both, within a very short time after the intra-laryngeal operation, the lymphatic glands became involved. . . . . While conscious of the value of removing portions of a laryngeal neoplasm for diagnostic purposes, I desire to express my strong conviction that it should not be resorted to in cases suspected to be cancer unless the patient is willing to have a radical operation performed immediately after the diagnosis is completed." A correspondence on the relation of intra-laryngeal surgery to malignant disease of the larynx will be found in the *Brit. Med. Journ.*, 1887, vol. ii.

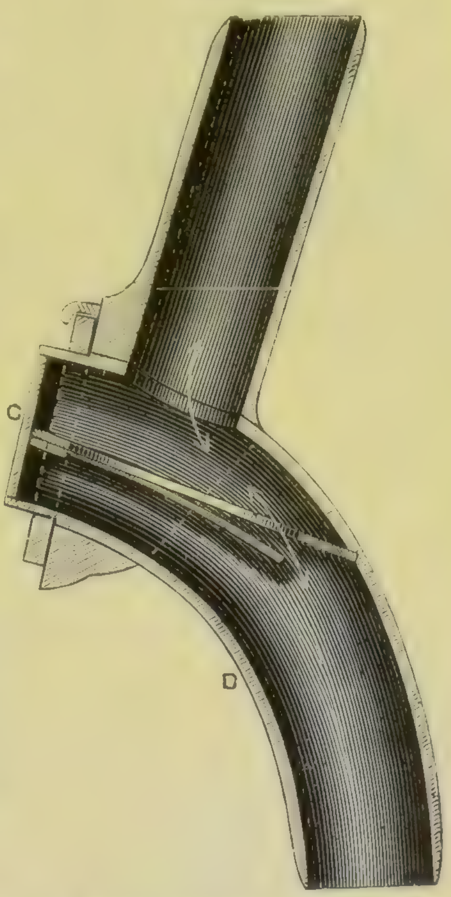
* In a case of total excision of the larynx by Mr. Morris (*Clin. Soc. Trans.*, vol. xx. p. 37) feeding with an œsophageal tube became necessary about the second day, owing to nutrient enemata not being retained. The patient took the strongest aversion to the tube, and Mr. Morris thought that the depressing influence upon the patient due to the loss of power of swallowing, and the prospect of having to submit to the use of the tube for some time, was not to be exaggerated.

patient should be encouraged to take some solid food by the mouth, liquid food thus taken having, always, a greater tendency to get into the trachea.

After partial removal, the patient will be able to dispense with the cannula, and to take food by the mouth within a few days of the operation. In about a month, an *artificial larynx* may be fitted. Of these the chief forms are Gussenbauer's, and Irvine's modification of this.

The following account is taken from a very complete, clear, and practical article by Dr. Cohen,* of Philadelphia, to which I am already much indebted for information. The appliance consists of three parts† — (1) a tracheal cannula; (2) a pharyngeal cannula, the two having apertures by which they can be passed through each other and admit a free current of air from below upwards; (3) an adjustable plate carrying a vibratory reed. This is detachable to allow of its being cleansed from mucus, being pushed in and out like a table-drawer. The apparatus being in position, the expiratory current, on its way to the mouth, sets the reed in vibration, and the tone thus produced, broken with articulate speech, is monotonous, modulation being impracticable. In an interesting case under the care of Dr. Macdonald and Mr. Symonds (*Clin. Soc. Trans.*, vol. xxii. p. 253), the patient, after complete laryngectomy, could speak in a loud, though rough, voice, which was not monotonous. This was produced by the vibration of two folds of mucous membrane of the pharynx. The patient could speak better without than with an upper tube, but

FIG. 95.



Dr. Foulis' modification of Gussenbauer's artificial larynx. The upper tube is shown above. B, The lower tube. C, The reed. (Mackenzie.)

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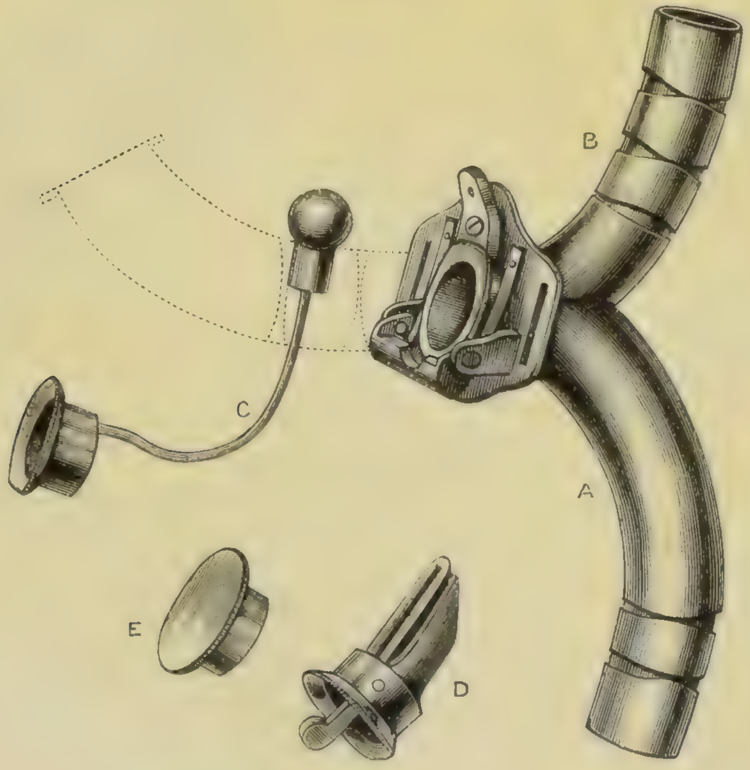
[*] *Internat. Encyl. Surg.*, vol. v. p. 777.

[†] Originally a substitute for the epiglottis was provided, maintained erect by a watch-spring weak enough to yield readily to the descent of the base of the tongue in deglutition. This has been found unnecessary and rather in the way. Dr. Cohen (*loc. supra cit.*) figures an instance of the very complicated apparatus which will be required when the anterior wall of the œsophagus has been removed.

the latter was necessary to keep the channel open. The dates in this case are as follows. The left half of the larynx was removed Oct. 1888, an uninterrupted recovery taking place. Dyspnœa soon after appeared, requiring tracheotomy Dec. 16. It was found that the right side of the larynx was attacked by rapid and extensive growth, and the larynx was completely extirpated Dec. 22, seven weeks after the first operation. The recovery was again an excellent one. June 19, 1889, a growth the size of a hen's egg occupied the lower half of the right anterior triangle. July 5 it is reported that the patient appeared to have but a few weeks to live.

Gussenbauer's artificial larynx* consists of a large tracheal tube (A) with rings below, corresponding to the natural flexibility of the trachea. Through its front plate and through an opening on its upper curvature passes a pharyngeal tube (B), made also flexible or not, according to the case, with an opening on its lower curved surface, so placed that a stream of air may play freely through both tubes, even though the external outlet be closed. The upper end of the pharyngeal tube lodges behind and below

FIG. 96.



Gussenbauer's artificial larynx. (Park.)

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* Dr. G. Fowler (*Amer. Journ. Med. Sci.*, 1889, p. 369) advises that this should be made of aluminium rather than silver or hard rubber, on account of the lightness of the former metal.

the epiglottis (if left), or behind and below the base of the tongue. Around it the œsophagus granulates and closes, so that, when healing is complete, the only passage from the pharynx into the trachea is by way of the metal tube. In order that fluids and solids may not pass through this, an obturator (C) is provided, which is passed through the external opening and up through the tube, so that its rounded upper end plugs the upper end of the pharyngeal opening, thus preventing the passage of anything into the trachea. But since this would also shut off the air, the obturator is attached below, not to a solid plug, but to a ring, as seen, which fits accurately into the external opening of the instrument, through which the patient breathes as long as the plug is worn. Except at meal-times a simple stopper (E) is worn, so that at all other times he breathes naturally through the nose and mouth. After a time, by education of the muscles, the upper end of the tube is protected during deglutition, and patients learn to swallow readily without the obturator. A substitute for the vocal cords is provided by a free metallic reed, playing freely in a movable slotted bar (D). This movable bar carrying the reed has an external lever, by which the wearer can, with a touch of the finger, throw it in and out of the air-current, and thus—as it were—voluntarily open or close the glottis. The sound thus produced by the reed in the air-current is converted by the articulating parts above into distinct speech, the voice, though a monotone, being a perfect voice, save in pitch.*

Great difference is presented in the toleration of these appliances. In some instances they give little trouble, and are used with great comfort. Some subjects bear the naked apparatus well, but cannot tolerate the phonal reed, which may impede respiration, may become obstructed with desiccated mucus, and may yield a tone to every breath of expiration. Some abandon them altogether, and stick to the simple tracheal cannula. In some instances saliva, mucus, and food will get into the tubes and descend into the trachea. Some patients prevent the escape of food by plugging the upper orifice when they eat.

Dangers and Causes of Death.

1. Shock.
2. Exhaustion. Both these are rarely met with, save when the hæmorrhage has been severe.
3. Suffocation from blocking of the tube during the first few days.

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* Park, "A Successful Case of Total Extirpation of the Larynx" *Ann. Surg.*, Jan. 1886.

4. Lung trouble—viz., broncho-pneumonia, purulent bronchitis, &c. This is the most frequent cause of death, from the passage of food, blood, &c., down the trachea in spite of careful plugging.* Dr. Cohen thinks that the period of danger from lung complications does not last over two weeks, and that if the patient survive this date, he is tolerably secure up to the fourth month, when death from recurrence begins to be imminent.

5. Septic cellulitis, mediastinitis, &c.

6. Secondary hæmorrhage. This occurred in Dr. McLeod's case (*loc. supra cit.*) on the fifth day, causing death rapidly. Its source could not be determined. The disease was extensive.

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* If the patient have, previous to the operation, any bronchitis, these fatal lung complications are especially likely, the bronchitis running on into broncho-pneumonia. For this reason Billroth (*Clin. Surg.*, p. 134) urges in such patients that every attempt should be made to improve the bronchitis, a preliminary tracheotomy being performed if needful.

CHAPTER XIII.

OPERATIONS ON THE THYROID GLAND.

REMOVAL OF THE THYROID GLAND,* PARTIAL AND COMPLETE.

Indications.

1. Failure of previous treatment and increase of bronchocele, leading to

2. Dyspnœa sufficiently constant to prevent the patient from following any active employment, or one of a sedentary kind which involves stooping of the neck and head.

3. The existence of tracheal stridor, especially if accompanied by much enlargement of the isthmus (see p. 438) or extension of the bronchocele downwards.

4. Attacks of sudden, suffocating dyspnœa.

It is not yet sufficiently recognized by the profession that a bronchocele, whether moderate in size or large, may from some sudden engorgement or rupture cause urgent and fatal dyspnœa. A first attack may here only herald in the end.†

The following may be quoted to prove that the above danger is well founded :—

Dr. Hurry (*Lancet*, March 19, 1887) gives the case of a girl, æt. 13, the subject of a moderate goître. Dyspnœa was first complained of November 3, on November 7 dyspnœa was urgent, and tracheotomy was called for. The operation gave very little relief, and death followed 1½ hour later. The post-mortem examination showed a moderately large goître, the two lobes of which entirely encircled the trachea and reduced the lumen to a narrow slit, to which the tracheotomy wound did not quite reach. Dr. Hurry gives the following ingenious explanation of the insidiousness and urgency of the dyspnœa in these cases:—Owing to the slowly progressive enlargement of the thyroid the dyspnœa at first is slight; one day some extra exertion calls into play the additional muscles of respiration—*e.g.*, sterno-mastoid, sterno-thyroid, sterno-hyoid, these, pressing on the trachea, still further close its lumen, already narrowed by the slowly progressive growth; this brings about additional dyspnœa, and so induces still further contraction of the inspiratory muscles, and so further closure of the trachea, and finally fatal dyspnœa.

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* A distinction must always be made in these operations between removal of parts of the thyroid itself and that of encapsulated adenomata in it, however large.

† Thus, in one case, a woman with a bronchocele which, as far as was known, had not given previous trouble, waking out of sleep suddenly, was terrified by seeing her little child playing about the room with a piece of wood taken alight from the fire. Most urgent dyspnœa set in, and before surgical relief could be given, death took place from suffocation. In another case, that of a woman, the subject of a bronchocele, and straining violently in the throes of parturition, the same dyspnœa set in as rapidly, and with the same result.

Dr. Dewes (*Brit. Med. Journ.*, January 18, 1879, p. 84) records the case of a patient who was found by the Coventry police apparently dying of suffocation. On his admission into the hospital a large bronchocele was found, and a free median incision was made by Mr. Read down to the tumour. The breathing at once improved, and soon became natural, the tumour decreased in size and all went well till the evening of the seventh day, when the dyspnœa suddenly returned, the tumour again enlarging, and the patient dying in two or three minutes. It was found, post-mortem, that in the last agony the posterior part of the tumour had broken down, giving rise to a large extravasation of venous blood, pressing on the respiratory nerves. "The only part of the trachea at all approachable was under the manubrium sterni, where it was covered by the innominate artery."

I wish to draw attention to this fact, that extravasation may take place suddenly into a bronchocele, thus producing urgent dyspnœa. In 1885 a woman, aged forty-four, came under my care with enlargement of the thyroid, the right half having been increasing in size for some years, but her chief trouble was due to a swelling, in the position of the isthmus, of the size of a small orange. This had existed about a year, but had suddenly increased in size, while the patient was singing, six months before. The patient's voice, originally an alto, was now hoarse and gruff, and of very small compass. An operation showed that the isthmus was occupied by an encapsuled adenoma of the thyroid (perhaps, originally, in the main cystic), containing in the centre firm coagulum. Two years later, when the patient was last seen, the right lobe had subsided to the size of its fellow, but the voice was still deep, and somewhat hoarse.

5. Dysphagia, if associated with the others now given.

6. Steady or rapid enlargement, with or without dyspnœa, if the enlargement be in a downward direction so as to become

sub-sternal. The lower down the growth has been allowed to extend the greater the risk of mediastinal cellulitis, if removal of the bronchocele is attempted, and the smaller the hope of giving relief by tracheotomy, if the dyspnœa comes on in these cases too urgently to admit of an attempt at extirpation.

The following case, given by Mr. Bryant,* is a good instance of the truth of the above :—A young man, aged nineteen, three months before his death, "became the subject of paroxysmal attacks of asthmatic dyspnœa, associated at times with a wheezing or whistling respiration and some general enlargement of the base of the neck. Three days before his death this difficulty became extreme, the paroxysms became more frequent and more severe, and on the day of his death a severe paroxysm took place, which passed on to a forced and heaving respiration, beyond anything I had ever before witnessed, and speedy death resulted. I performed tracheotomy with the slender hope that some light might be thrown upon the nature of the case to guide us in its treatment, if not to give relief, but in doing so what was probable before became evident—viz., that the obstruction was below. I had no perforated instrument with me long enough to force down, so a female catheter was used, but it struck against some solid body that prevented its progress. After death the thyroid body was found to be much enlarged, but mainly below the sternum and along the sides of the trachea. The trachea below my opening was flattened laterally to within ½ inch of the bifurcation; it was also twisted to the left, and was surrounded by the greatly enlarged and firm lateral lobes of the thyroid."

7. Inability to stoop without "a sensation of blood to the head," dizziness. This was very marked in a man, aged forty-eight, sent to me by Dr. Graham, of Pullborough, with general enlargement of the thyroid, especially of the left lobe. Removal of this and the isthmus was followed by great shrinking of the right lobe, the patient being now enabled to follow his occupation of brickmaking in comfort.

8. Inability to sleep lying down. A woman, aged thirty-eight, under my care, whose mother had died at forty-three from suffocation by a bronchocele, was much troubled by the above symptom. Entire relief followed removal of the largest lobe and the isthmus.

9. Constant dragging pain in the neck. This will be met with in large and weighty tumours.

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* *Surgery*, second edition, vol. i. p. 192.

10. Improvement of personal appearance. An operation should never be here entertained by the surgeon, unless he is dealing with a small growth and has sufficient reason to have confidence in himself and his patient to be able to keep the wound aseptic from first to last.*

Cases in which an operation is contra-indicated, or in which it must be performed with additional caution.

1. Huge bronchoceles, especially if broadly fixed.
2. Calcified bronchoceles.
3. Those with ill-defined limits.
4. Those which are already sub-sternal, owing to the risk of mediastinal cellulitis.
5. Age—*e.g.*, in patients over fifty.
6. Patients with very feeble pulse. Schwartz thinks that feeble action of the heart will be often met with in goître, and attributes this partly to interference with respiration due to pressure on the veins and the trachea, and partly to the intervention of a more or less voluminous vascular network in the circulation, thus producing a strain on the heart.

Dangers of the Operation. Immediate and Later.

1. Hæmorrhage. This can usually be met by paying careful attention to the details given below in the account of the operation. The arteries are usually easily commanded; it is the veins which give trouble, being numerous and thin-walled, and, in the severer cases, met with at every step of the operation. In these cases also, when the growth is soft as well as vascular, any opening of the capsule is liable to give rise to flooding of the wound with blood and great difficulty in finding the bleeding point, thus causing risks of including in the ligature or otherwise injuring important parts, such as the recurrent laryngeal. Even in the removal of a small tumour, if soft and rapidly growing, most severe hæmorrhage may be met with. Thus Mr. Foy (*Dub. Med. Journ.*, 1888, vol. i. p. 242), after shelling out a tumour the size of a hen's egg, met with such copious bleeding that the application of seven clip forceps gave " no appreciable check to the flow." The wound was plugged with new sponges, kept in

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* The following is the advice of Billroth on this matter: "Large prominent bronchoceles in people above forty years of age, with slight or no dyspnœa, should not be operated on just for the sake of appearance. I think that small bronchoceles connected to the lower part of the thyroid in children and young people should be more often removed, especially when their situation is such that the tumour might, with increased growth, possibly entail some danger."

place by uniting the wound with wire and figure-of-eight sutures. The patient recovered.

2. Injury to the recurrent laryngeal nerve, asphyxia, aphonia. This most grave accident has happened with sufficient frequency to put any surgeon on his guard. The injury may be due to including the nerve in a ligature, cutting the nerve, or seriously bruising it. Richelot,* writing in 1885, found nine cases in which it was certain that the recurrent laryngeal had been cut during the operation. He gives the following causes of aphonia after the operation:—(1) Wound of inferior laryngeal nerve; (2) dragging of this nerve; (3) perhaps section of the crico-thyroid branch of the superior laryngeal; (4) months after operation it may come on from inclusion of the inferior laryngeal nerve in the cicatrix; (5) when the laryngeal symptoms are progressive from ascending neuritis (Schwartz). This may be present before the operation, and so, too, may be (6) compression of the inferior laryngeal by the goître.

Sir M. Mackenzie (*Brit. Med. Journ.*, 1881, vol. I. p. 595) has related a case in which a slight "fibroid," extremely hard enlargement of the thyroid, caused paralysis of both recurrent nerves, with aphonia and dysphagia in a man, aged fifty.

M. Richelot, after discussing the results of section and irritation of the recurrent laryngeal, thinks that the sudden dyspnœa and aphonia must be attributed to division of the recurrent with irritation of the upper end.

Whatever the exact cause is, it is certain that the dyspnœa and aphonia are not always permanent.† On this point the two following cases of M. Richelot, and mine at p. 458, are of much interest:—

In a woman, aged twenty-five, suffering from suffocating dyspnœa, the operation was followed by aphonia, which lasted for three months, and by complete paralysis of the cords. The operation was performed with great care, and there is no reason to think that either of the recurrents was cut, but it is possible that they were bruised or stretched; however, in four months the cords regained movement and the voice was fully restored.

In the second case, aged twenty, a hard, mobile tumour, the size of a walnut, was attached to the isthmus by a narrow pedicle, and the gland itself, though apparently somewhat hypertrophied, was not prominent. But, when exposed, it was found that the tumour had a broad attachment to the isthmus, and that the two lobes of the thyroid were greatly hypertrophied, closely embracing and compressing the trachea ; it was therefore thought desirable not only to remove the tumour, but also to dissect out the whole gland. When recovering from the effects of chloroform, the patient was suddenly seized with cyanosis and threatening asphyxia, and though she partially recovered, on the next day there was aphonia, dysphagia, and uninterrupted dyspnœa, and she died asphyxiated in the evening. Both recurrent laryngeals had been cut, and the upper end of the left one was included in a ligature.

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* *L'Union Méd.*, Nos. 17 and 18, 1885; *Med. Chron.*, June 1885.

† Owing to the definite supply given to the muscles of each side by the corresponding nerve, actual laceration or division of the nerve will be followed by equally definite paralysis.

Injury to the nerve is especially likely to occur under the following conditions :—(*a*) when the growth is huge ; (*b*) when it is very fixed by adhesions (which are uncommon), or by a broad base ; (*c*) when it is ill-defined ; (*d*) when it encircles the trachea and œsophagus closely ; (*e*) when it is malignant.

3. Septic cellulitis leading to purulent and diffused mediastinitis. These are very likely if the wound becomes septic. In such cases the latter complication is almost certain, even in small goîtres, if they dip down behind the sternum, owing to the difficulty of providing adequate drainage. The accompanying symptoms are :—Pain in the region, coming on soon after the operation and increasing, followed by feebleness of the pulse, distress, and dyspnœa, and speedy death.

4. Myxœdema, both acute and more deferred. This strange condition, which has so unexpectedly overclouded otherwise successful operations for complete removal of an enlarged thyroid gland, was first noticed and published by two Swiss surgeons, Kocher and Reverdin.* The correct explanation will probably be found to be the one which Prof. Horsley brought before the profession in his lucid and convincing Brown Lectures of 1885.† The issues here treated are so wide, the experimental researches are so complete and far-reaching, that any abstract must, unintentionally, seem to do them an injustice. The following are the points of chief importance to the operating surgeon :—

Effects of Excision. Phenomena following Complete Thyroidectomy in Monkeys.—" At a variable period after the operation, but averaging five days, the animal is found to have lost its appetite for a day or two, and, on closer examination, to exhibit slight constant fibrillar tremors in the muscles, of the face and hands and feet more especially. These tremors disappear at once on voluntary effort. At the same time, the animal is noticed to be growing pale and thin, in spite of the appetite, &c., returning quickly with great increase; rapidly the tremors increase, affect all the muscles of the body without exception, the animal becomes languid, paretic in its movements, and imbecile. Then puffiness of the eyelids and swelling of the abdomen follow, with increasing hebetude. During these last stages the temperature, gradually falling, becomes subnormal, and then the tremors disappear as they came. Meanwhile the pallor of the skin often becomes intense, and, leucocytosis having been well marked, oligæmia follows, and the animal dies perfectly comatose in a variable period, but usually about five or seven weeks after the operation."

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* *Arch. f. Klin. Chir.*, Bd. xxix. S. 254, 1883.

† *Brit. Med. Journ.*, January 17 and 31, 1885 : "The Thyroid Gland : its Relation to the Pathology of Myxœdema and Cretinism ; to the Question of the Surgical Treatment of Goître ; and to the General Nutrition of the Body."

Post-mortem Appearances met with after Complete Thyroidectomy.—Prof. Horsley thus sums these up: "Ablation of the thyroid causes atrophic changes in the central nervous system, and in the fat generally. It causes an increase in the general connective tissue, and a mucoid conversion of the ground substance. This increase of mucin in the connective tissue is accompanied by an extraordinary secretion of the same stuff by means of the salivary glands, and also those of the alimentary canal."

While these changes are going on, the hæmapoietic tissues, especially the spleen, are found to have undergone obvious compensatory hypertrophy.

Theories explaining Myxœdema, Cachexia Strumipriva, and Cretinism.

Prof. Horsley discussed the three following, he himself maintaining the third to be the correct one:—

i. Kocher's view, that the symptoms of myxœdema which follow complete thyroidectomy are brought about by chronic asphyxia, due to narrowing of the trachea, consequent on softening and atrophy, produced by ligature of the thyroid vessels which supply the trachea and œsophagus as well. Prof. Horsley finally disposes of this view by remarking that there are numerous cases of marked stenosis of the larynx and trachea on record, but not a symptom of myxœdema has here been noticed. Furthermore, in his experimental thyroidectomies, the larynx and trachea were found absolutely normal and patent.

ii. Dr. Hadden's view that the myxœdematous state of malnutrition is brought about by a general spasm of the arterioles and capillaries, the spasm being maintained by central disturbance in the sympathetic ganglia. This view regards the atrophy of the thyroid as due to constriction of the blood-vessels, and therefore of secondary importance. It has been accepted by Kocher on the assumption that in the operation the sympathetic nerves are injured and irritated by being included in the ligatures placed on the vessels. It is set aside by Prof. Horsley because (*a*) it has been found experimentally that, if the gland be exposed, and the nerves going to it are divided, the symptoms of myxœdema do not appear; (β) in Prof. Horsley's experimental thyroidectomies which were followed by myxœdema, the irritation of the nerves was only, he considers, momentary; (γ) the sympathetic trunk and ganglia appear to be, microscopically, absolutely normal.

iii. The theory * that the four varieties of a general state of mal-nutrition, given below, are due to the loss of function of the thyroid gland, perhaps through disturbance of the nervous centres, leading to vaso-motor or trophic changes in the tissues.†

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* Prof. Horsley also deals with some objections which have been raised to his theory—(1) Even if in the above-named conditions—viz., cretinism, myxœdema, cachexia strumipriva, and cachexia after thyroidectomy, a thyroid body be discovered post-mortem, it does not follow that this was in full normal function. (2) If one lobe be excised, the other hypertrophies; if this enlarged half be now removed, the animal presents many of the symptoms described. In answer to the statement of Schiff that, provided an interval of about three weeks elapses between the operations, the symptoms do not appear, or, at any rate, are not fatal, Prof. Horsley replies that even if the above observation is to be trusted the mitigation of symptoms can readily be understood, as the spleen will have had time to provide for the hæmapoietic functions of the gland.

† Prof. Horsley thus tabulates the most striking of the anatomical and physiological facts bearing upon experimental myxœdema:—

"1. The thyroid gland appears to consist of two distinct portions—(*a*) glandular, consisting of highly vascular acini, which excrete into their interior a mucoid substance, this substance, or something closely similar, being found in the lymph-vessels of the gland—mucin-excreting function? (*b*) highly vascular, lymphoid nodules—hæmatogenous function.

"2. Excision of the gland is followed, according to my experiments, by an increase in the amount of mucin in the tissues which normally possess it, by a retrograde histological change, by an increase in the activity of the glands which normally excrete it, and, what is still more striking, by the assumption of the muciparous function by a gland which normally produces none, or very little mucin—the parotid gland.

"3. Excision of the gland is followed by profound changes in the blood—namely, a diminution of the number of corpuscles, preceded, as regards the number of the white elements, by a temporary increase in their number, by an alteration in the coagulability and albumins, and by an abnormal presence of mucin.

"4. Excision of the gland is followed by nerve-symptoms indicating changes in the lowest motor centres, these changes causing tremors, with rigidity and

The following cases, with the results of operation, support Prof. Horsley's views. They might be multiplied by other published cases, and it is probable that many other temporarily successful thyroidectomies have been followed by myxœdema, but that this ending of the cases has not been made known.

Volkovitch, of Kiev (*Lond. Med. Record*, 1885, p. 148), removed the whole gland, in a woman aged thirty-eight, for dyspnœa and dysphagia indicating operative interference. Death took place four months later, with marked evidence of cachexia strumipriva—*i.e.*, anæmia and weakness, tetany of hands and legs setting in five days after the operation, and becoming, later on, more general, numbness of hands, myxœdematous condition of the integument, striking apathy, difficulty in articulation and respiration.

Sir W. Stokes (*Brit. Med. Journ.*, October 16, 1886) has published a case in which a somewhat similar fatal result followed complete thyroidectomy. A healthy woman, aged eighteen, was admitted with extensive enlargement of both thyroid lobes, causing urgent dyspnœa, especially at night. It was found impossible to remove more than the left lobe owing to the profuse hæmorrhage, which proved almost fatal. A good recovery took place, followed for a while, by relief of dyspnœa and diminution in the size of the right lobe. In about six weeks, however, the right lobe was as large as before, and the thrill and dyspnœa were again present in an intensified form. The right lobe was removed with even greater danger from syncope. Within a fortnight convulsive seizures set in, and fatty swellings were noticed about the eyelids, backs of the wrists, and over the metatarsi. Mental torpor also appeared, and the aspect of the face became gradually one of imbecility. The convulsive seizures recurred, with lividity of the face, stertor, dyspnœa, protrusion of eyes, dilatation of the pupils, and throbbing of the carotids, followed by copious perspiration The patient became weaker and died, with symptoms of pulmonary infiltration, ten days after the second operation. The very brief account of the post-mortem only mentions the brain, heart, and lungs; of these, the two former "contained nothing abnormal, the lungs were highly œdematous."*

Mikulicz, of Cracow, states that the published cases of cachexia strumipriva after thyroidectomy already number thirty-five, and

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paresis; it is also followed by changes in the higher psycho-cortical centres, such producing imbecility, and, ultimately, death in the comatose state."

* In a similar case I would advise either ligature of the vessels to the remaining lobe, or removal of half of this.

he adds another. As to other evils which may result from total thyroidectomy, he says that Weiss, in 1883, found thirteen cases of tetany, and Mikulicz himself has had four cases in seven operations. He also cites three cases, two of his own, in which epileptic convulsions followed total extirpation.

It is right to state that other observers have failed to trace the above sequence. Foremost among these is the experience of Billroth, who, in 1883, had performed extirpation sixty-eight times, with a mortality of only 7.3 per cent., and without once observing cachexia strumipriva. Créde, of Dresden (*Congress of German Surgeons*, 1884), reported fourteen cases of complete extirpation without one case of myxœdema following.

Sir W. MacCormac (*Brit. Med. Journ.*, 1884, vol. ii. p. 231) mentions, in explanation of Kocher's results, the opinion of Bardleben, "that the cretinoid condition observed by Kocher may very well have followed in his cases, irrespective of the extirpation of the gland, and that the enlarged thyroid was but a link in the chain of symptoms, dependent rather on the locality from which the patient came, than on the circumstance that extirpation of the goître had been practised."

However this matter may finally be cleared up, the fact remains beyond dispute that in many parts of Europe symptoms akin to those of myxœdema have followed complete thyroidectomy, especially in young subjects.* Why this sequence has not been invariable, and what the explanation of it is when it does appear, is as yet uncertain. But, till this matter is cleared up, I am distinctly of opinion that complete extirpation of the thyroid is as yet unjustifiable. It is certainly an operation of many undoubted risks, such as hæmorrhage, injury to the recurrent laryngeal (p. 439) and the trachea, and septic troubles. In addition, the great risk of myxœdema remains, an uncertainty perhaps, but still to be reckoned with. On the other hand, we have operations which are infinitely safer, such as ligature and removal of the isthmus, and removal of one-half to be followed, if needful, by ligature of the arteries to the opposite half later on.

Operation for Removal of One-Half, and the Isthmus as well if required.—I recommend this operation most strongly. I have performed it in ten cases of ordinary bilateral bronchocele. All the patients recovered; all experienced great relief from their dyspnœa which has been progressive and lasting. In all shrinking of the opposite half of the thyroid followed. I am strongly of opinion that this operation will be found quite sufficient, while very much less risky than total extirpation. In one case (p. 451) it was performed for a case of exophthalmic goître. The parts having been cleansed, and the patient's head and shoulders conveniently supported, the surgeon makes a free incision over the most prominent part of the tumour which he is going to remove, avoiding any large veins. An ample longitudinal incision* will nearly always give all the room that is required, and such a scar will be little conspicuous, falling, as it does eventually, into the sulcus just internal to the sterno-mastoid, a point of much importance in women.

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* Of Kocher's sixteen cases, in which cachexia strumipriva was developed, nine were under twenty years of age, five between twenty and thirty, and only two above thirty. Eleven were young women; five were males.

The skin and platysma being cut through, any superficial veins carefully tied, the deep fascia is slit up and the gland itself exposed, bluish-red and with large veins on its surface. Spread also over this are usually one or more of the depressors of the hyoid bone, often much expanded; these are separated with a blunt dissector, or divided, if needful, between chronic gut ligatures. One or more large retractors are now inserted so as to draw outwards the sterno-mastoid and large vessels, while the surgeon with his left index finger, or a blunt dissector, frees the enlarged part of the thyroid from its bed, shelling it forwards, and probably finds it only fixed above, below, and internally, by the thyroid vessels and the isthmus. In effecting this separation, the greatest care must be taken to work gently and to keep close to the tumour,† the veins being often much enlarged and thin-walled.‡ The upper extremity of the tumour being first isolated, the superior thyroid vessels are found and tied either with double ligatures of chromic catgut or carbolized silk passed with an aneurism needle, or divided between two pairs of Spencer Wells' forceps, the two ends being tied. This effected, the tumour is next isolated in a downward direction, and any outlying masses turned out from beneath the sterno-mastoid. The next step usually taken is similar isolation, ligature, and division of the inferior thyroids, but I prefer to take the isthmus next, being of opinion that the more the growth is freed and isolated, and the less fixed it is, the more easily are the inferior thyroid vessels dealt with, and the less danger is there of damaging the recurrent laryngeal.

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* The incision can either be made as above, laterally, or it may be angular with a straight limb in the median line from hyoid to sternum, and one passing obliquely outwards and upwards from the upper end of the first. If the surgeon still persists in removing the whole gland, the incision may be Y-shaped. In cases, as in that of Sir W. MacCormac (*loc. supra cit.*), where the skin is adherent after the use of setons, &c., the incisions must be made so as to enclose and remove the adherent skin and cicatrices.

† The capsule of the tumour must nowhere be opened. Such a step not only leads to flooding of the wound with blood, but thus also obscures and may lead to damage of important parts—*e.g.*, the recurrent laryngeal and trachea.

‡ While it is quite impossible to give any adequate idea of the number of vessels which may be met with in a large and difficult case, it will be well to recall the principal vein-trunks. The superior thyroid vessels enter at the upper angle; a little below these, emerges laterally a superior accessory vein (Kocher). The same surgeon describes as constant a superior and inferior communicating vein as lying above and below the isthmus, the former joining the two superior thyroids, and the latter entering into the thyroidea ima vein. The inferior thyroid vessels pass behind the outer border of the thyroid, and for some distance behind it, before penetrating it with its several branches. A little above the inferior

The separation of the isthmus is best effected with a steel director, care being taken to keep the isthmus as much off the trachea as possible, and the point of the director close to the isthmus. When this body has been sufficiently separated, it may be ligatured after transfixion with an aneurism needle carrying carbolised silk or strong chromic gut, or it may be carefully torn through with the point of a director, and each bleeding-point secured.* The amount of hæmorrhage met with in detaching and

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thyroid vessels emerges the inferior accessory thyroid vein. The anterior jugular will have to be dealt with, and the positions of the internal jugular, and, below, of the innominate veins, will have to be remembered in the case of huge tumours. The above veins are figured by Sir W. MacCormac (*loc. supra cit.*) in an illustration taken from Kocher. In a case which Mr. Jessop and Mr. Berry record (*St. Bar. Hosp. Rep.*, 1889, p. 103) the position of the internal jugular was worthy of special notice, lying, as it did, spread out upon the outer side of the left lobe of a large bronchocele. "Instead of bearing the normal relation to the carotid, it lay well in front of and *internal* to it. Consequently the pulsation of the artery in such cases is not a safe guide to the position of the vein. We wish to lay stress upon this point, since we believe that it is mainly to ignorance of this altered relation of vein to artery that the not uncommon accident of a wound of the vein during extirpation of the goître is to be attributed. We believe that the explanation which Lücke gives of this abnormal relation is correct. The common carotid, having no branches, is displaced outwards by the goître; the jugular, being attached by its branches to the front of the thyroid gland, cannot be displaced to an equal extent, and consequently comes to lie at first in front of, and also internal to, the artery." Whether the above statement that wound of the internal jugular is a "not uncommon accident" in these operations is correct, may, I think, be doubted, in this country at least. The above case is well worthy of perusal.

* If the pedicle seem too thick and vascular to treat in this way, which may be the case in colossal bronchoceles, it should be subdivided and tied in several pieces, like a stout ovarian pedicle, the ligatures being made to interlock. If this cannot be managed, and if the patient's condition admits of it, the pedicle may be slowly divided by an écraseur, or seared through with the cautery. In such case the stump should be brushed over with a solution of zinc chloride, gr. x–ʒj, dusted with iodoform, and, if possible, brought outside the wound.

dividing the isthmus varies. If the separating is effected piecemeal, the bleeding is often very slight. This is probably accounted for by the fact that the intimacy of connection and continuity of structure between the halves of the thyroid and the isthmus varies much also ; in many cases the connection is mainly by connective and a little glandular tissue, with very few vessels.

The tumour, now almost completely isolated, is drawn to one side, and especial care is taken before ligaturing the inferior thyroid vessels. These should be most carefully isolated and inspected, so as to avoid injury to, or including, the recurrent laryngeal. Owing to the fact that the trunk of the inferior thyroid artery does not come into relation with the recurrent laryngeal till both are close to the trachea, either the trunk of the vessel should be ligatured and cut at some distance from this tube, or its branches tied close to the gland.

If the vessel is tied near the junction of cricoid and trachea, the nerve may very likely be included, and the same risk is run if at this stage especially, the wound is not kept dry and bloodless.

After the removal of the tumour, the wound should be examined for any bleeding-points, adequate drainage then provided, and the wound carefully closed, save below, to allow of free escape of discharges here, and thus to avoid any risk of burrowing, and mediastinal cellulitis.

If during the operation there is any evidence of syncope, the head should be lowered and injections of ether or brandy given. Both the surgeon and the assistant who is giving the anæsthetic must be on the look-out for evidence of dyspnœa or asphyxia. If any evidence of it occur, it is an indication for the surgeon most carefully to examine the tissues which he is handling, and the amount to which he may be dragging upon the air-passages in the manipulation of the tumour. Tracheotomy seems nearly always to be a fatal complication,* partly by rendering such a deep and important wound septic, partly by causing septic bronchopneumonia, and partly by adding to the shock in a patient already collapsed by so severe an operation.

If tracheotomy appear urgently needed, the surgeon should try first slitting up more freely the deep cervical fascia or dividing any stretched muscles, in order to relieve the trachea and breathing.

In the event of the operation having to be performed, great difficulties must be expected, and the surgeon should be provided with long soft tubes, in case there is any mediastinal prolongation pressing upon the lower part of the trachea. Every possible attention must be paid to keeping the tracheotomy wound sweet with applications of iodoform, iodoform and ether, &c. Sir W. MacCormac mentions the need of keeping the head very steady during the tracheotomy, and, later on, with sand-bags; he advises leaving the thyroidectomy wound open and treating it with frequent irrigation, if tracheotomy has been found necessary. Irrigation with mercury perchloride (1 in 2000) should be used at intervals throughout. The wound left after removal of one enlarged lobe only, is often vast and deep, the larynx, trachea, œsophagus, and common carotid being all exposed. In two of my cases the dome of the pleura has been exposed, rising and falling in the root of the neck. The wound is a difficult one to drain satisfactorily, from its lower portion dipping behind the sternum. In order to obviate any collection of fluid, before the wound is brought together, all irrigating fluid, blood, clots, &c., should be most thoroughly sponged out, a little iodoform is then carefully dusted into all the recesses of the wound. Two drainage-tubes should be made use of, one from the deepest part of the wound to its lower angle, and one through the whole length of the wound. When much disturbance of the parts laterally has been needful, and in one of my cases the common carotid was displaced into the posterior triangle, it will be well to pass a tube laterally by counter-puncture, avoiding the jugular veins. A narrow, dry sponge is inserted while the sutures are put in. I prefer fishing-gut and horsehair carefully rendered aseptic; the former are passed through the whole thickness of each lip of the wound, and at some distance from it. When the sutures are all in place, the sponge is withdrawn before they are tied. The edges of the wound should be brought into most exact apposition, to promote sound healing. I have observed a distinct tendency for the scar to become keloid; this condition is, however, only a temporary one. When all the sutures are tied, the wound is again irrigated and insufflated, and elastic pressure is made with two or three aseptic sponges well wrung out. Over these some gauze slips are placed, and then the gauze bandages, so as to get firm, even pressure, distributing the discharges evenly through the dressings. Other gauze dressings are then applied. The patient should be kept propped up in bed, and his head well steadied with sand-bags.

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* In five of Billroth's cases in which tracheotomy was performed three died. Kocher's experience has been the same.

For the first few days after thyroidectomy, care must be taken to keep the dressings securely in position. This is especially difficult in a mobile part like the neck, which does not admit of compression. The safest plan is to pass the gauze bandages under the axillæ below, and, above, to wind them over the chin and forehead, points of friction being carefully packed with salicylic wool, and all made secure by stitching. This alone will keep the dressings from slipping down.

Unless primary union is secured throughout, any silk ligatures used are liable to come away for many months. Thus, Sir W. MacCormac (*l.s.c.*) relates a thyroidectomy lasting two hours, in which at least a hundred ligatures were used. Six months later a sinus was still discharging ligature-threads (*vide infra*, p. 457).

Question of Operation in Cases of Malignant Disease of the Thyroid.—The surgeon must consider here most carefully whether any operation is justifiable. In the first place the risk of injury to the recurrent laryngeal is much increased from the tendency of a malignant growth to creep round the trachea, dip into the sulci between the large vessels and the windpipe, and to infiltrate important parts. Secondly, these growths, especially if rapid, tend to creep down into the anterior mediastinum,* behind the sternum. Thirdly, in addition to these dangers, must be considered that of glandular invasion—*e.g.*, cervical, mediastinal, bronchial—and the doubtfulness of getting all the growth away, and the increased risks of hæmorrhage and cellulitis. Mr. Sydney Jones and Mr. Battle have published (*St. Thomas's Hosp. Rep.*, vol. xvii. p. 232) an interesting case of sarcoma of the thyroid. The malignancy probably supervened upon previous ordinary enlargement of the gland. It was operated on repeatedly, for the first time very extensively, one sterno-mastoid being divided, July 16, 1887. A second operation, November 2, found both the sheath of the carotid and the œsophagus involved. Two months later, tracheotomy was required owing to fresh recurrence. Two further operations were performed in the next three months, and the tracheotomy tube now not proving long enough, the useful device of securing a piece of large drainage-tube to a full-sized Durham's cannula made the patient comfortable. A little later, April 5, 1888, severe hæmorrhage took place from the common carotid, and two ligatures were applied above and below an opening in this vessel. The patient sank two days after, some dyspnœa having returned at the last. Notwithstanding the rapid recurrence, life was prolonged with comfort by the repeated operations for some months. In the fact that "the local malignancy was great, the general malignancy *nil*," this case of sarcoma contrasts strongly with the much more common carcinoma.

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* A remarkable instance of malignant bronchocele is figured by Billroth (*Clin. Surg.*, pl. ii. and iii.). It was a soft carcinoma, and extended down behind the sternum, compressing the right innominate vein, and causing enormous dilatation of the superficial veins of the neck and front of the trunk.

Dr. Rotter (*Arch. f. Clin. Chir.*, Bd. xxxi. Heft 4; *Year-Book of Treatment*, 1885, p. 138) gives details of fifty cases of cancer of the thyroid submitted to operation. Of these eight died in the first twenty-four hours, five at the end of the first week, and eight at the end of the second week. Only four patients remained free from a recurrence at the end of six months. These figures point very strongly to the conclusion that in malignant disease of the thyroid attempted removal is most rarely justifiable.

Mr. Butlin (*Operat. Treat. of Malig. Dis.*, p. 206) thinks that "at present the number of instances in which a cure of the disease can be claimed is so small * that the operation is scarcely justified." The following facts, to which Mr. Butlin draws attention, are worthy of careful notice: (1) The large number of cases in which secondary affection was discovered at the autopsy, even when death occurred within a few days after the operation; (2) The frequency with which it was found impossible to entirely remove the tumour; (3) The difficulty of diagnosis in the early stage of malignant disease of the thyroid. The chief points which should be looked to here are early fixity and irregularity of outline, to which Mr. Butlin, quoting from Rose, adds continuous growth † and marked dysphagia.

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* He thus analyses the cases in the paper by Dr. Rotter, quoted above, and two others by Dr. Rose and Dr. Braun (Langenbeck's *Arch.*, 1879, 1883). Of fifty cases submitted to operation thirty were fatal. Of the twenty which survived the operation, a recurrence took place in ten, which was either fatal or promised rapidly to be so. In two the operation was abandoned. In three the further history was not known, and in one it only extended to a period of two months after the operation. In four only was a result, which Mr. Butlin courteously calls favourable, obtained. One, a patient of Bircher's, was well eleven months after operation. In the second, Bruns removed some enlarged glands a year after the first operation, and two and a quarter years later the patient died of inflammation of the lungs. The third, a patient of Maas', was reported to be quite well nearly four years after the operation; and the fourth, under the same surgeon, died in twelve months of some uncertain lung affection.

† Rose has pointed out that the surgeon is liable to be deceived on this point by the effect of remedies. Thus, potassium iodide may cause a diminution in the size of the neck, a fact which may be attributed to the effect of the drug on the general enlargement of the gland, which is frequently associated with the occurrence of more or less limited malignant disease. Attention has already been drawn at pp. 353, 405 of this book to the procrastination (sometimes pernicious

Thyroidectomy for Exophthalmic Goitre.—I have only operated in one of these cases, a young woman of twenty-two, at the request of Dr. Goodhart, and Dr. Garrard of Rickmansworth. Proptosis had been noticed for three years, but the enlargement of the thyroid for only six months. Both lobes, especially the right, and the isthmus were much enlarged, the latter extending down to the sternum. The whole gland was spongy, and pulsated slightly, in addition to receiving pulsation from the carotids. A marked thrill could be felt over it. A venous bruit could be heard at the lower part of the right lobe, a systolic bruit over the pulmonary, and one much less marked over the aortic area. Slight attacks of dyspnœa had recently appeared, especially at night, "with wheezing." There was occasionally some difficulty in swallowing. Chloroform was taken quietly. An incision, about 7 inches long, being made from behind the right angle of the jaw to the left sterno-clavicular joint, the tumour was exposed by slitting up the deep fascia and partly dividing, partly retracting, the hyoid depressors. The three parts of the thyroid were intimately fused, thick, and fleshy; the isthmus had crept down to the manubrium. A very striking feature was five or six huge veins, the size of the axillary, coursing over the front of the tumour to dip down behind the sternum. The thyroid vessels on the right side were first found and tied, the inferior being dealt with by tying its branches very close to the gland, so as to avoid the recurrent laryngeal nerve. The right lobe was then dissected from the trachea with a steel director, the adhesions being intimately close by firm connective tissue not very vascular. The large veins already mentioned having been secured with double sulphurochromic gut ligatures, the isthmus was next freed from the trachea and its junction with the left lobe carefully transfixed with a steel director. Along the director an aneurism needle loaded with stout gut was passed. The loop of this was drawn through and cut, and the two halves of the above junction tied tightly. The right lobe and the isthmus were then cut away. Recovery was most satisfactory, the patient being up on the eleventh day. There was still some throbbing over the left side, but this was no longer perceptible to the patient. The basic bruits had disappeared. When the patient was last seen, two months after the operation, the shrinking of the neck remained, and she was quite free from the attacks of dyspnœa, and the palpitation of the heart

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in its results) which this temporary result of giving potassium iodide may bring about in malignant disease.

was less troublesome. It was to prevent these last that the operations had been performed, not with any hope of curing the proptosis or cardiac trouble. In other words, it was to give relief to a symptom, rather than to cure a disease which, with its three chief symptoms, proptosis, thyroid swelling, and disturbed cardiac action, depends on some cause not yet elucidated, that I operated. The case must be watched before any real conclusions can be drawn as to the value of the steps taken.

Treatment of Enlarged Thyroid by Operations on the Isthmus.—This method consists in excising the isthmus after applying double ligatures, or in trusting to double ligatures alone. It was first recommended in this country by Sir D. Gibb (*Lancet*, 1875, vol. i. p. 120), and more recently by Mr. Sydney Jones.

In Sir D. Gibb's cases the patients were young women whose bronchoceles had resisted other treatment. In one case there was general enlargement of the thyroid, especially on the right side, the isthmus could be felt, distinctly rounded, and projecting somewhat over the trachea. Mr. Holthouse exposed the isthmus, and after placing a ligature on either side, removed it. About six months later the patient was entirely free from her old symptoms—tension, dyspnœa, &c.—and the lobes appeared to have receded laterally, and to be less prominent.

In the second case there was much enlargement of the veins owing to extension downwards of the bronchocele. Cough, dysphagia, and, at times, urgent dyspnœa were present. When Mr. Holthouse exposed the isthmus it suddenly cropped up like a hernial tumour. After cautiously detaching it with curved scissors, two ligatures were passed under it as widely apart as possible. As they seemed likely to become detached if the isthmus was cut away, they were left in to slough out. The patient made a good recovery with much relief to her symptoms.

Mr. Sydney Jones has recorded (*Lancet*, November 24, 1883) the case of a patient, aged eighteen, who had noticed the swelling about eight years; latterly it had increased rapidly. The dyspnœa was marked, the least exertion bringing on paroxysms. The thyroid was greatly enlarged, the right lobe being much the larger, while the isthmus could be traced extending below its usual position, as a band about 1 inch in vertical measurement. An incision about 3½ inches long being made in the middle line, transverse branches of the anterior jugular vein being tied and turned aside, the isthmus was detached by the finger and director from the front of the trachea. An aneurism needle was then made to perforate, which it did easily, the junction of the isthmus with each lateral lobe. The double ligature on each side was tied as with an ovarian pedicle, and the isthmus cut away. There was very little hæmorrhage. The trachea was very much compressed, of triangular shape, with the apex forwards, and each lateral surface somewhat concave. Immediately on removal of the isthmus much relief seemed to be afforded to the patient. The dyspnœa quickly ceased, and when the patient left, in less than two months, the thyroid could not be felt.

I have followed Mr. Sydney Jones in three cases, and can recommend this operation most strongly. All three cases presented enlargement of the gland generally, in addition to hypertrophy of the isthmus. In two of them the women were over thirty, with marked distress in breathing, on exertion, and altered, hoarse voice. The mother of one of the patients had died, aged forty-four, suddenly with dyspnœa accompanying enlargement of the thyroid. Two of these cases have been kept under observation for three and one and a half years respectively; in both the general enlargement has subsided steadily, with entire relief of symptoms. The third case showed great hypertrophy of the whole thyroid, the isthmus consisting of a bi-lobed tumour reaching from the top of the thyroid cartilage to just below the manubrium. This patient was operated on more recently, but the measurements of the neck showed a diminution of 1½ inch within a week of the operation; this decrease went on advancing, so that a fortnight later the enlargement of the right lateral lobe had entirely disappeared, and that of the left almost equally so. The marked tracheal stridor, breathlessness on any exertion, but only weakened voice, were accounted for by finding the windpipe in this case an excellent instance of "the scabbard trachea," this tube being bluntly keel-like in front with concave surfaces from the strap-like pressure of the enlarged isthmus. The sides of the thyroid cartilage showed, from the same cause, very marked concavities. This girl, sent to me by Dr. Fraser of Romford, instead of being a nervous, exacting invalid at home, is now working as a nurse at one of the London hospitals.

I would most strongly urge a further trial of this operation in the following cases:—When the isthmus is distinctly enlarged in (*a*) cases of colossal growths where the surgeon does not care to undertake more;* (β) where, owing to the anæsthetic being not well taken, the time for operation is limited; (γ) where, the lateral lobes being little affected, the isthmus is the seat of the enlargement, especially if tracheal stridor be present. If with general enlargement dyspnœa is present, removal of one of the lateral lobes as well as the isthmus gives much more speedy and decided relief. I accordingly prefer the latter operation wherever the lateral lobes are much enlarged. The isthmus can be raised without difficulty with a steel director or blunt dissector from the trachea, it is then transfixed at its junction with the lateral lobes, or through these themselves, with a double sulphuro-chromic gut ligature (this should be tested beforehand). The ligatures being tied, the gland-tissue is snipped through between them, the isthmus removed, and the stumps pared away as close to the remaining ligatures as is safe.

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* In these cases the shrinking of the lateral lobes may be slow.

Treatment of Enlarged Thyroid by Ligature of the Arteries.—This operation was performed in 31 known cases (Wölfler, *loc. infra cit.*), but was given up, (1) from deaths due to wound-treatment of former days, (2) from imperfect results, as the inferior thyroid was never ligatured at the same time.

Prof. Wölfler,* of Vienna, considering that the various methods of treating goître are still open to objections, has lately advocated a trial of the above method. In October 1885 he made use of it in a patient aged twenty-nine, who had much dyspnœa from a rather large colloid thyroid; the right half being somewhat the larger, both the thyroid arteries were tied on this side, and also the median thyroid vein. The patient was discharged nine days later, the dyspnœa being considerably relieved and gradually subsiding completely. The neck, however, did not diminish in size at the same rate. A week after the operation the median circumference had diminished 1 cm., and seven months later 6 cm., when the right side of the goître had shrank to one-half its former size; the left side had diminished somewhat. Prof. Wölfler considers that facts indicate (1) that neither tying both superior thyroids nor the inferior alone can be considered sufficient, owing to the free anastomoses. (2) It is as yet questionable whether in large one-sided goîtres ligature of both thyroids on that side ought to be accompanied by ligature of the opposite superior thyroid. (3) Ligature of all four arteries could hardly lead to gangrene of the thyroid.

It would perhaps be well to make further trial of this operation in cases of bronchoceles requiring an operation from dyspnœa, &c.,

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* *Wien. Med. Woch.*, 1886, Nos. 29 and 30; *Ann. of Surg.*, December 1886, p. 523.

and in which, after removal of one-half, the diminution in the opposite half is either temporary, or does not take place at all (p. 443). I think, too, that in very large thyroids this method might be combined with removal of the isthmus.

These vessels vary so much in situation and course, according to the size and growth of the bronchoceles in different directions, that any dissections for finding them must be uncertain. The chief points to bear in mind are the upper and lower parts of the enlarged lobe : the superior thyroid artery is often rendered superficial by the upper limit of the tumour raising it up. Both vessels may be enlarged and somewhat softened, and thus secondary hæmorrhage may readily occur unless the wound is kept sweet.

Ligature of Superior Thyroid Artery.

RELATIONS.—This vessel, the first branch of the external carotid, arises just above the bifurcation, about a quarter of an inch below the great cornu of the hyoid. At first, covered only by thin fasciæ and the platysma, it ascends slightly, and then curves downwards with a tortuous course, covered by the depressors of the hyoid bone and the sterno-thyroid.

Operation.—The patient's head being suitably raised, and turned to the opposite side, an incision, about 2 inches long, is made along the inner border of the sterno-mastoid, with its centre corresponding to the upper border of the thyroid cartilage. The superficial parts being divided, the sterno-mastoid and the large vessels are drawn outwards, and the omo-hyoid downwards and inwards, or else tied and divided. The artery is then searched for with the point of a steel director in the hollow between the larynx and the carotid. Some enlarged veins, belonging to the superior thyroid, will probably require division after the application of double chromic gut ligatures.

Ligature of Inferior Thyroid Artery.—This operation is a good deal more difficult, owing to the depth of the vessel and its more important relations.

RELATIONS.—The artery, the largest branch of the thyroid axis, ascends tortuously inwards behind the carotid sheath, the middle cervical ganglion and its branches lying in front of it. Before entering the gland it lies for a little distance in relation with its posterior surface, and in this part of its course the recurrent laryngeal is in close contact with it.*

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* Sir W. MacCormac (*Lig. of Arteries*, p. 71) says that the nerve often passes between the terminal branches of the artery. He reminds the operator that the left artery is in close contact with the œsophagus, and that the thoracic duct,

GUIDE.—The carotid tubercle of Chassaignac, or the transverse process of the sixth cervical vertebra. Sir W. MacCormac gives the body of the fifth cervical vertebra, opposite to which the artery enters the thyroid gland. The common carotid is also a guide.

Operation.—An incision, 3 inches long, being made along the anterior border of the sterno-mastoid coming down to the clavicle, as if for ligature of the carotid low down, the deep fascia is opened and the sterno-mastoid and the structures in the carotid sheath drawn outwards. The head being now flexed to relax the parts, the carotid tubercle is felt for, and the artery sought for below it, by carefully working here with a director. The vessel should be exposed and the ligature applied as close to the carotid as possible, and thus at some distance from the thyroid gland, so as to avoid injury to the recurrent laryngeal, which, as above stated, crosses over the trunk or ascends among the branches of the inferior thyroid. The neighbourhood of other important structures must be remembered.

Treatment of Thyroid Cysts (Fig. 97).—These are sometimes of much importance owing to their size, their important relations, and, as shown by Mr. Clutton's case below, by their occasional vascularity.

The best treatment is antiseptic excision whenever this is practicable; with much larger and older ones, the safest and the one most generally applicable is antiseptic incision and drainage. Injection with iron perchloride has given some good results, but there is always the risk of suppuration and cellulitis in a very dangerous region owing to the presence of the larynx above, the mediastinum below, and of numerous veins, these being liable to puncture, and thus to immediately fatal thrombosis, or, later on, to septic phlebitis.

Where the cyst is moderate in size and not of very long duration, it may often be excised, and the case given below shows that this may sometimes be practised where the cyst is huge in size and of long duration. But in the majority of large cysts it will be a safer, though more tedious, practice to incise the cyst and drain it with careful aseptic precautions, a method which is applicable to nearly all cases, and which gives the surgeon the opportunity of exploring the cyst, especially in those cases where it is covered over with a layer of gland-tissue, or where it has complicated contents.

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at first posterior, arches over the artery on this side to enter the left subclavian vein.

The above remarks apply to single cysts. Mr. Clutton (*St. Thomas's Hosp. Repts.*, vol. xvi. p. 173) has pointed out that where there are many cysts, or where a cyst is combined with much disease, the whole half of the thyroid affected had better be removed.

The method of incision usually involves a very simple operation. The soft parts having been duly cleansed, an incision is made through them down to the cyst, and any bleeding points secured. The cyst is then slit open and its interior examined. These may vary considerably both as to thickness and contents, and vascularity of lining membrane. Thus the contents may be a serous, mucoid, gelatinous, or grumous material, or coagulated blood-clot. The amount of vascularity is of twofold importance: if of very long standing the cyst-wall may be so fibrous and evascular that sloughing of it may readily take place, especially if the wound becomes septic. On the other hand, it may be ex-extremely vascular (Clutton, *loc. supra cit.*), in which case such abundant hæmorrhage will take place as to leave no time for suturing, and require immediate plugging with aseptic gauze.

Knowing how tedious these cases are in granulating from the bottom and becoming completely obliterated, I prefer to suture the cut edge of the cyst to the surrounding margin of the skin, and then, with a sharp spoon, to scrape over the lining membrane, thus promoting the closing of the cavity from the bottom. A drainage-tube is then inserted, the cavity plugged with strips of gauze, and the dressings applied. Mr. Clutton, however, considers that sutures are not necessary if the tissues between the cyst and the skin have not been much disturbed; if the contrary has happened, sutures may be harmful, as they would tend to prevent escape of discharges from the meshes of the deep cervical fascia.

I would again draw attention to the very important fact that in these, as in all other thyroid cases (and in many others) where primary union is not secured, silk ligatures, if many of these have been used, may continue to come away for a very prolonged period. The cyst quickly falls in and puckers together, but a sinus is liable to persist through which ligatures are long discharged. Thus, in one of Mr. Clutton's cases a sinus persisted for two years, and then quickly closed; in another the patient was still wearing a drainage-tube a year after the operation. And in the case of mine now mentioned, it was not till nine months after the operation that the last ligature came away, and the wound soundly closed.*

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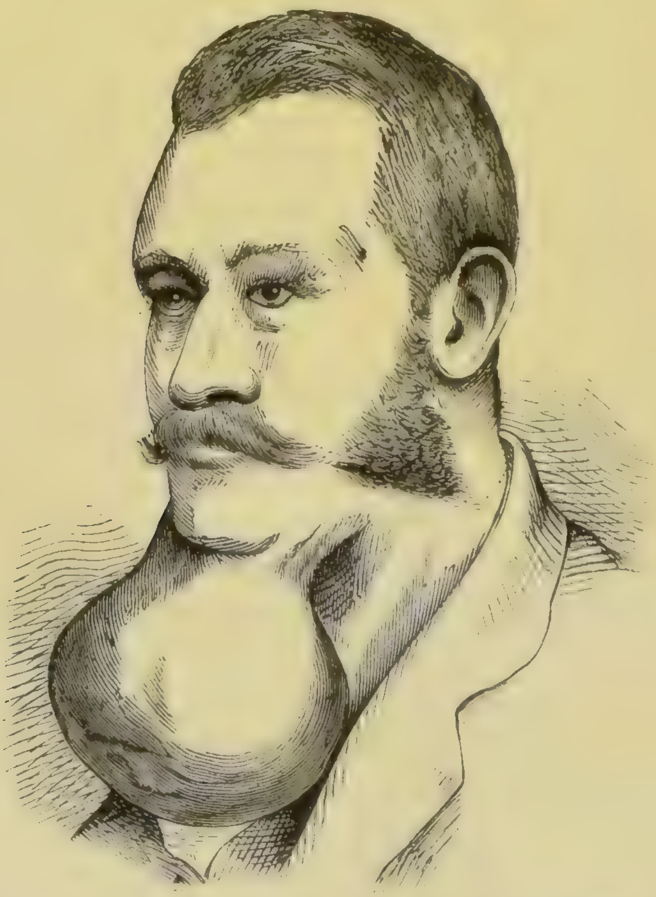
* In this case plaited-twist silk (Turner's) was used. This is so closely inter-

As bearing on the treatment of thyroid cysts by excision, and as a good example of one of the complications which may follow operations on the thyroid gland, I may now mention the following case (Fig. 97) :—

A gentleman, aged fifty-five, was sent to me, towards the close of 1885, by Mr. Cooper Forster, with a right-sided thyroid cyst, almost colossal in size, and reaching from the ear to below the clavicle, and outwards, into the posterior triangle. The trachea was under the edge of the left sterno-mastoid. The swelling was first noticed twenty-six years before, being then about the size of a hazel-nut. About nineteen years before, owing to some dyspnœa, the swelling was tapped by Mr. Forster ; gradually refilling and increasing in size, it was tapped by myself in 1885, the fluid being thick with material resembling Parmesan cheese. As the cyst quickly refilled, I proposed free incision and drainage, and sought first the opinion of my colleague, Mr. Durham. As i spite of twenty-six years' history the cyst had a certain distinct

FIG. 97.



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woven as to resist changes in the tissues and absorption most obstinately. I hav been much disappointed at the way in which it keeps a sinus persistent and come away long after such operations as radical cure of hernia, nephrorraphy, an nephrectomy. For buried sutures or ligatures ordinary silk of appropriate thic ness is much to be preferred, being equally safe and of a much more open textur though limited amount of mobility, Mr. Durham advised extirpation in preference to incision. This counsel I accordingly followed. Ether was taken very badly, especially at first. An incision being made from the angle of the jaw to the right sterno-clavicular articulation, the sterno-mastoid was found spread out over the cyst and adherent to it, perhaps from the previous tappings. As the patient was breathing very badly, no time was spent in separating the muscle, but the cyst was reached by cutting away the adherent part. The superior thyroids being found and tied, the cyst was turned downwards out of its bed, partly with the finger, partly with a blunt dissector; a vessel in the position of the middle thyroid vein was found, and a small vessel below where the inferior thyroid was expected. The chief attachment of the cyst was in the middle line, where it was connected with the isthmus (not itself enlarged) by a fairly fleshy pedicle. This was separated from the trachea and tied in three pieces, partly with the aid of a steel director, partly with an aneurism needle. About fourteen carbolized silk ligatures were used, and strict antiseptic precautions were taken throughout, including the use of the spray. An enormous cavity remained when the cyst was shelled out, exposing the common carotid and its bifurcation, the larynx and trachea, but though a strong light was thrown into the bottom with a mirror, nothing could be seen of the œsophagus or recurrent laryngeal. Special care was taken to verify this, as towards the close of the operation (which lasted twenty-five minutes) there was some vomiting of coffee-grounds stuff, streaked here and there with brightish blood.

No dyspnœa and no lividity had been noticed during the operation, beyond the difficulty which had from the first accompanied the anæsthetic. As the effects of the ether subsided, a peculiar stridor was found to accompany the breathing, being much more marked in inspiration. The voice was not affected, beyond being weak, and there was no lividity. The stridor, but without marked dyspnœa, went on increasing for about two hours, the patient being much alarmed from dreaded "choking." Though he vowed that he could not swallow owing to the above alarm and from the feeling of soreness "like a bone in the throat," he was persuaded to take a dose of potassium bromide, and passed a fairly good night. The next day was a comfortable one, and the breathing, which was twenty in the minute, was much easier, and perfectly so while the patient slept. The next two days were very anxious ones, the stridor returning, with great restlessness and distress, on account of paroxysmal attacks of dyspnœa. Accompanying these a condition of quiet delirium set in. The respirations ran up to 40, the pulse to 140. while the temperature remained 99°. The wound was now, and throughout, perfectly sweet. As there was some carboluria (without albumen), the drainage-tubes were syringed out with boracic acid, and iodoform gauze dressings applied as before.

The pulse was of grave omen, about every ten or twelve beats dropping, fluttering, and then, as it were, staggering on, to intermit again in another ten beats. This, Dr. Goodhart thought, might be due to some chloral that had been given at night.

The diagnosis now was doubtful—whether one of injury to the recurrent laryngeal, or one of œdema glottidis. Mr. Durham, who inclined to the latter view, advised the use of warm, moist, boracic acid lint-dressings, and inhalations of steam and terebene.

The breathing gradually became less laborious and noisy, and the power of swallowing quickly returned. Recovery was retarded by a succession of fogs and some localized pneumonia, which, giving anxiety at first, entirely cleared up under Dr. Goodhart's hands. When the patient left town, six weeks after the operation, there was no difficulty in swallowing, the stridor was only noticed on deep respiration, or during quick or prolonged talking. The wound was now represented by a sinus at the lower end; all the rest was well healed. Ligatures continued to come away for nine months, when the wound healed at once. There is now, four years after the operation, still a very little stridor on deep breathing or rapid talking, and the voice is still a little husky, but the patient is able to follow his employment actively and to get quickly over hilly ground.*

While the diagnosis here remains obscure,† I am of opinion that, with the bloody vomit in the course of the operation, and the great dysphagia afterwards, although the huge cyst turned out so quickly, some slight injury was inflicted on the œsophagus, with stretching or imbedding in inflammatory effusion of the right recurrent laryngeal. Whether this is right or not, I think, with all proper deference to Mr. Durham's opinion, that this case shows that, in cases of thyroid cysts, when large or of long standing, incision with antiseptic precautions is preferable to excision.

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* A year after the operation he wrote thus: "I have not been so strong and active for many years. The other day I went in the morning to London, to the Academy, Grosvenor, 'Alice in Wonderland,' Fitzroy House, then to a council-meeting of the Photographic Society, and home. There was a damp fog all day, and I am not the worse for it."

† Owing to a projection of the incisor teeth, and a life-long difficulty in opening the mouth widely, it was found impossible—Mr. Durham and Dr. Goodhart also trying—to get a view of this patient's larynx.

CHAPTER XIV.

REMOVAL OF LARGE DEEP-SEATED GROWTHS IN THE NECK.

Before deciding to undertake the removal of one of these, the surgeon should consider carefully the following points :—

A. **The nature and surroundings of the growth.**

B. **His operative skill in these cases, and his knowledge of anatomy.**

C. **His experience in antiseptic surgery and in keeping a large wound aseptic.**

The chief growths which call for a decision are the following :—The rarely met with more innocent ones—*e.g.*, the enchondroma of Prof. Spence,* the fibrous tumour of Mr. Butcher,† glandular tumours, including the more simple strumous lymphomata, when they do not yield to other treatment; sarcomata, very likely cystic, originating in the neck apart from the cervical glands; sarcomata of the glands ; carcinomata of the glands, secondary to epithelioma of the tongue, lip, &c.

Of the three points above mentioned, it will only be needful to consider separately the first ; the importance of the two others will be sufficiently shown in the remarks on the operation and after-treatment.

A. **The Nature and Surroundings of the Growth.**‡—In examining into these, careful attention should be paid to the following :—*Duration. Rate of increase. Amount of fixity.*

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* Growths of the tonsil are considered at p. 377 ; bronchocele at p. 435.

† This case, in which the growth weighed over 7 lbs., is related in the *Dub. Journ. Med. Sci.*, November 1863. Mr. Butcher's case will be found amongst his *Operative Surgery Essays*, p. 809. The reader should also consult Mr. Holmes' remarks on these cases (*Syst. of Surg.*, vol. viii. p. 886), a paper by Mr. Barker (*Lancet*, 1886, vol. i. p. 194), and one by Mr. Jessett, illustrated by some admirable photographs (*Brit. Med. Journ.*, 1886, vol. ii. p. 712).

‡ Mr. Holmes (*loc. supra cit.*) quotes Langenbeck (*Arch. f. Klin. Chir.*, Bd. i. Hft. 4, S. 14) as pointing out that, in tumours which involve the sheath of the vessels, engorgement of the veins of the face is rarely absent. In one case he observed this venous engorgement to be on the opposite side to the tumour. This he attributed to the fact that the tumour compressed the carotid artery as well as the jugular vein, as proved by the weakness of the temporal pulse.

Whether early established, and how far absolute. This point is of the utmost importance. The gravest cause of fixity is, of course, a growth with a wide base, or numerous root-like processes extending into important parts. The fixity should be tested by seeing how far the finger-tips can be insinuated beneath the growth, how far it can be lifted up, and the amount of its connection to parts such as the jaw and larynx, the head being steadied by an assistant while the growth is lifted up and its deep processes put on the stretch as much as possible. *The outline.* Is this well marked or indistinct, and, if the latter, is it in dangerous regions such as the parotid, the zygomatic, and other fossæ, that the growth is lost? *Its relation to important structures, and the degree to which it blends with them.* Thus, any evidence of pressure on vessels and nerves, trachea and pharynx, &c., should be carefully looked for—*e.g.*, weakness of temporal pulse, engorgement of veins above, alteration of pupil, numbness of upper limb, dyspnœa, or dysphagia. Does the growth dip near or into the thorax? How far under the sterno-mastoid does it go? Are the glands enlarged as well? Is the skin involved? This last point, together with fixity, indistinctness of outline, rapid growth, softness, and fusion with surrounding parts, are of chief importance, and, if co-existing to any extent, will usually put any operation out of the question.

Even when the surgeon is doubtful as to the advisability of meddling with one of these growths, he may decide to make an attempt under the following circumstances, even if it end in failure :—

When the patient's life is rendered worthless by the present wretchedness and approaching dangers of the growth, especially if he be young, as in the words of Mr. Butcher (*loc. supra cit.*, p. 871) :—

"Though the boy did not suffer pain, yet his life was rendered very miserable . . . . the weight ever tending to depress the head, occasioning persistent fatigue and even pain in the muscles of the neck, and so compelling the patient often to adopt the recumbent position, the bulk thrusting up the head, embarrassing every movement, almost preventing any change of position ; the pressure impeding respiration, often obstructing it during sleep so as momentarily to threaten suffocation, making the patient start from his bed in terror and alarm, unrelenting or enforcing one attitude during sleep, with difficulty in deglutition, except under extreme watchfulness in adopting position."

So, too, in some cases of cancerous glands, associated with pithelioma—*e.g.*, of the tongue—the surgeon may justifiably erform an extensive operation, such as Kocher's (p. 370), in the ope of removing both the primary and secondary epithelioma, or fter a successful removal of the tongue operate on the infected glands widely and deeply to give the patient another prolongation f life. In such cases it should be the patient who urges the peration after all the risks have been placed before him.

Main Points in the Operation itself.

i. **Free Exposure of the Growth.**—The incisions should be ufficient, the flaps turned back V, Γ, or X in shape. Thus, if he growth be in the anterior triangle, not encroaching on the osterior, a V-shaped flap with the base upwards, one limb long the sterno-mastoid and the apex above the sternum, may be mployed; or one Γ in shape, the long limb inside the above-mentioned muscle, and one at right angles to it under the jaw. If the growth invade both triangles, and if it will be necessary to divide the sterno-mastoid, an incision obliquely across both triangles, and over the muscle, from mastoid process to sternum, and then a second to make it conical, will be the best. It is always to be remembered that inadequate exposure of the tumour will lead to groping in the dark, bruising of the soft parts, and injury to important structures.

ii. **Deeper Dissection.**—In this attention must be paid to—

(*α*) Working as much as possible with a blunt dissector, a steel director, or the finger, using the scalpel and blunt-pointed scissors as little as possible, and keeping them turned towards the growth. The dissection should be begun, as a rule, where the growth is most free, and where its relations are not important.

(*β*) Tying with reliable sulphuro-chromic gut every vessel before it is divided, not only to minimize the loss of blood, but also to avoid the risk of air entering the veins, especially low down in the neck.

(*γ*) Structures, hitherto thought too important, may be divided, if really needful. Thus, not only the sterno-hyoid and omo-hyoid should be divided, but the sterno-mastoid also. Of the structures in the carotid sheath, the internal jugular is, as pointed out by Mr. Holmes, the most likely to be implicated. It may be divided without hesitation after it is secured with two catgut ligatures.*

In the autumn of 1887, while operating for Mr. Cooper Forster, I tore through the internal jugular vein in removing some epitheliomatous glands: the hæmorrhage was for a moment very profuse, but yielded to sponge-pressure. Catgut ligatures were applied to the two halves of the vein, and the patient recovered. In a similar operation the lingual vein was separated so close to the internal jugular as to leave little more than a rounded opening. In preference to tying the vein above and below I left a pair of Spencer Wells' forceps on for three days. Recovery took place. The common carotid and even the vagus have been divided, and without a fatal result.

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* Mr. Barker (*Lancet*, 1886, vol. i. p. 194) records a case, probably a cystic sarcoma, in which 1½ inch of this vein and part of the scalenus anticus were involved in the growth and removed. The case did well.

M. Sabat * successfully extirpated a tumour extending from the mastoid process to the clavicle, and lying altogether beneath the sterno-mastoid, which was divided in order to expose it. The carotid and internal jugular had to be tied, and the pneumogastric nerve was divided.

In a case of Dr. Gibson (*Amer. Jour. Med. Sci.*, vol. xiii. p. 305), a tumour was successfully removed after the carotid and internal jugular had been tied and divided.† The descendens noni was cut, but the vagus was dissected out of the mass. The patient recovered from the operation, but the growth recurred, though it was enveloped in a very firm and distinct capsule.

In a deep dissection the presence of some other structures must be remembered.‡

Mr. Godlee (*Clin. Soc. Trans.*, vol. xix. p. 321) showed a child in whom, during the removal of a deep-seated growth, the nature of which was doubtful and which was pressing upon the pharynx, the cervical sympathetic had been wounded. The only results were, that the pupil on that side was smaller but not stationary, and that the ocular slit was also smaller.

In 1870 I saw the thoracic duct opened in an operation for the removal of enlarged glands on the left side. Chyle escaped deep down in the wound, and the case soon ended fatally.

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* This and the next case are given by Mr. Holmes (*loc. supra cit.*, p. 887).

† Mr. Jessett (*Brit. Med. Journ.*, 1886, vol. ii. p. 713) mentions a case in which he divided the common carotid and internal jugular vein in removing epitheliomatous glands from the neck. The man recovered, and lived in comparative comfort for nine months, death taking place from a local recurrence. In a case of Mr. Pughe's (*Ill. Med. News*, Sept. 29, 1888), of removal of a lympho-sarcoma of the neck, the carotid passed through a large gland, and was ligatured above and below, about ½ inch of the vessel being cut away. The internal jugular was secured well away from the growth. On the fifth and sixth days hæmorrhage took place from sloughing openings in the vein, and death took place rapidly.

‡ In the posterior triangle growths springing from the lower vertebræ or the first rib may involve the cords of the brachial plexus, causing much pain and requiring very tedious dissection for their removal. See a case brought before the Medico-Chirurgical Society, January 12, 1886, by Dr. Bruce and Mr. Bellamy.

(δ) If possible, the growth-capsule, which is often soft and delicate, must not be ruptured. On examining the growth after removal, the capsule should not only be entire, but any process should be blunt and rounded, not soft and ragged, as if torn away from parts left behind.

If the surgeon feel doubtful as to any portion being left, as in the fossæ about the base of the skull, he should use a sharp spoon and Paquelin's cautery, or pack in lint with a paste of equal parts of zinc chloride and flour (p. 265).

(ε) Throughout these operations, which may necessarily be prolonged and attended with loss of blood, and in which important parts may be disturbed and pulled upon, the surgeon should keep himself informed as to the effects of the anæsthetic.

iii. **Closure of the Wound and Application of Dressings.**—After completely removing the growth and any outlying glands, drainage is provided from the extremities of the resulting cavities, and in accordance with the position which the patient will occupy. Tubes of sufficient size being in position, the wound is brought together with wire or carbolized silk, or salmon-gut and horsehair sutures; dressings of sal alembroth or iodoform gauze are then adjusted, pressure being applied, wherever discharge might collect, with aseptic pads or sponges. Firm, even bandaging is then made use of to distribute the discharge equally throughout the dressings, and to keep the parts at rest. Owing to the mobility of the neck, and the impossibility of applying firm pressure over the trachea, it is always well to carry the bandages, below, across the axillæ, and, above, on to the face and forehead, and to have them stitched together in several places. Unless it is absolutely indicated, the wounds should not be looked at for five or six days.

Operative Treatment of Scrofulous Glands.—This may be given here owing to the greater frequency of this disease in the neck. *Question of Operative Interference.*—The following abundantly justify something more vigorous than mere local treatment, when this has failed:—(1) The fact that one gland has power to infect others, even when the local starting-point has been cured. (2) The disease, if merely palliated, is often extremely tedious, keeping the patient from the enjoyment and activity of some of the best years of life. (3) The scars which follow on a natural cure are far more disfiguring and extensive than those after a well-planned operation. (4) That during the long years of natural cure the repeated suppurations and the blighted life cause grave deterioration of the general health, which may persist for life, long after local cure has taken place. (5) The poor vitality thus induced, and in a large number of cases the actual presence of the tubercle bacillus, render the patient very liable to such diseases as phthisis.

The most useful methods are three—(A) Scraping or scooping out; (B) Excision; (C) Cautery-puncture, as practised by Mr. Treves (*Syst. of Surg.*, vol. i. p. 233).

(A) *Scraping or Scooping Out.*—I have put this first, as it is the method most often called for, owing to the frequency with which patients present themselves for treatment with one or more glands already caseating. It is applicable both in cases of glands caseating or suppurating, with the skin unbroken, and in those where a sinus already exists. Its value has been most clearly proved in the instructive papers on Scrofulous Neck and the Surgery of Scrofulous Glands put forth by Dr. Allbutt and Mr. Teale as clinical lectures at the Leeds School, from which so much good surgery has already come. The following are Mr. Teale's conclusions as to the surgical treatment of these cases; a wide experience has long ago convinced me of their absolute truth:—(1) That surgery can secure the healing in a very few weeks* of gland cavities and sinuses, even though they have existed for years. (2) That, in dealing with sinuses, gland abscesses, and decayed or semi-decayed lymphatic glands, the action of the surgeon must be vigorous and thorough. (3) That the visible abscess, which would often be called, and treated as, a strumous suppurating gland, is, as a rule, merely a subcutaneous reservoir of pus, its source, a degenerate gland, being *not subcutaneous*, but *sub-fascial*, *i.e.*, under the deep cervical fascia, and sometimes even sub-muscular, the communication between the two being a small opening just large enough to admit a probe or director. (4) That it is utterly futile merely to incise or puncture such a subcutaneous abscess dependent upon a degenerate gland which lies beneath the deep fascia. (5) That when a damaged or suppurating gland has been got rid of before the overlying skin is thinned by advancing suppuration, the resulting scar is insignificant, and not an eyesore. (6) That, in dealing with a sinus, the channel should be enlarged by the knife or a "Bigelow's dilator," and the whole of its granulating surface scraped out. Where the skin is thin and blue, this should be scraped away, and any cutaneous overhanging edges trimmed off with scissors. (7) That, in dealing with a sinus or an abscess, the surgeon should not rest content until he has discovered and eradicated the gland, always remembering that, if it be not obvious, there is sure to be a small track leading to it through the deep fascia. This should be enlarged so as to admit a sharp spoon. (8) That, when a gland has suppurated or become caseous, the capsule should be freely opened, and the contents scraped out. This is sometimes easy, the enucleation leaving the stiff capsular case virtually cleaned out. Sometimes it is very difficult to get rid, even by the most vigorous scraping, of a tough living stump of gland firmly adherent to the capsule. It is well to dissect this remnant away with a scalpel, if the risk of injuring important structures be not too great. (9) That sometimes, when such an empty capsule is left, the finger detects in its wall a bulging contiguous gland. This should be pricked through the wall of the cavity, and so reached and enucleated. In this way, in more than one instance, Mr. Teale has emptied from one external opening a group of three or four glands, suppurating or broken down.

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* In severe cases several operations, five or more, will be needed. After the first one or two the general condition rapidly improves.

I prefer to dress these cases, after scraping, with iodoform and hot boracic acid for a few days, as this best prevents cellulitis, while the moist warmth promotes the absorption of surrounding thickening and infiltration. A fine drainage-tube should also be inserted into the deepest recess. After a few days the above may be removed, and a small sealed dressing of dry gauze (see chapter on "Antiseptic Treatment") applied. Mr. Hilton long ago drew attention to the influence of rest in making otherwise intractable sinuses, &c., heal in a part so readily disturbed as the neck. Mr. Treves has more recently insisted on this point in the after-treatment of these cases. It is one of very great importance. Any of the leather collars which have been devised for cervical caries, and which, after careful moulding, take a fixed point on the shoulders below, and bear up efficiently the jaw and occiput above, will suffice. If in very restless mortals it is impossible to get a fixed point from the shoulders and root of the neck, the collar must have its base moulded round the thorax. When the parts are thus kept at rest, the child must spend its time out of doors in the best air available.

(B) *Excision.*—The cases to which this is best suited are those where there are two or three conspicuous glands—*e.g.*, in the submaxillary region—which have resisted treatment, and which, being movable and not yet softened, will shell out readily. And where, in scraping, glands are met with which have not suppurated, and which are fairly movable, they should be enucleated. With regard to a third class, where one or both triangles are full of glands, an operation by competent hands on the lines already laid down in this chapter may be very beneficial. But with regard to these extensive cases, Sir W. Savory's warning, quoted by Mr. Treves (*loc. supra cit.*), must always be remembered: these glandular swellings are often very deceptive; however well defined, superficial, and movable they appear through the skin, they will often be found, in an operation, to creep into parts very difficult of access, and to lead on to other and other glands, till perhaps the operation closes with as many left behind as have been removed.

(C) *Treatment by the Cautery.*—This has been recommended by Mr. Treves (*loc. supra cit.*). He uses a fine point of a thermo-cautery, heated to a bright red, thrust into the substance of the gland, and passed through it in several directions before it is withdrawn. Broken-down tissue is discharged, and the gland soon shrinks. I much prefer the sharp spoon to this method, not only because I think the operation more thorough, less in the dark, and an aseptic one, but also because gland tissue blended with a thick capsule, adherent to and receiving its blood-supply from the adjacent parts, will persist almost for a lifetime, unless completely eradicated. This can, I think, be only efficiently done by scraping.

It is the persistence of this poorly but sufficiently vitalized gland tissue which renders merely opening an abscess, the floor of which is formed by an imperfectly broken-down gland, so often futile unless the sharp spoon is used.

CHAPTER XV.

OPERATIONS ON THE ŒSOPHAGUS.

ŒSOPHAGOTOMY. ŒSOPHAGOSTOMY. ŒSOPHAGECTOMY.

ŒSOPHAGOTOMY.

Indications.—This is required for such foreign bodies—*e.g.*, tooth-plates, bones, coins—as have resisted careful, justifiable attempts at extraction, bodies which are certain, if left, to lead to grave results—*e.g.*, hæmorrhage, sloughing, deep cervical suppuration, &c.

It will be wise to proceed to an early operation, and thus avoid the risks of a fatal result from those conditions given at p. 473. In making up his mind to submit his patient to an operation, the surgeon must weigh the size and character of the body, the time it has been swallowed, the urgency of the symptoms—*e.g.*, dysphagia, dyspnœa from pressure on the larynx, emphysema,* œdema, &c., and whether the attempts already made at extraction are all that are justifiable, and whether the instruments at hand have been appropriate.

Operation.—The head being somewhat extended and turned to the right† side, the neck shaved (if needful), the surgeon makes an incision 3 inches long from just above the thyroid cartilage to within ½ inch of the sterno-clavicular joint,‡ a little in front of the anterior border of the sterno-mastoid. Skin and fascia being divided,* the cellular tissue in front of the above-mentioned muscle is opened up with a director, and the pulsation of the artery and the bodies of the cervical vertebræ, fifth and sixth, felt for. The omo-hyoid may be drawn down, but it is best to divide this muscle between chromic-gut ligatures, and, if it be needful to seek for the body low down in the neck, the sterno-hyoids and sterno-thyroids also. The sterno-mastoid and large vessels are now drawn outwards, and the trachea† inwards, with retractors, the thyroid gland probably showing plainly on the inner side, and the internal jugular, if dilated, on the outer. The presence of the inferior thyroid behind the carotid sheath, and that of the recurrent laryngeal running up in the groove between the trachea and œsophagus, must be remembered. Throughout these steps of the operation the bleeding must be most carefully arrested, and the deeper part of the wound, with the important structures around it, kept quite dry.

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* In a case where emphysema already exists with an impacted foreign body, it will be wiser to open the œsophagus at once, and not make attempts at extraction. Dr. Church (*St. Barthol. Hosp. Reports*, vol. xix. p. 55) gives a case in which swelling of the neck began three hours after the tooth-plate had been swallowed. The next day, after several attempts with a horsehair probang, the plate, which lay midway between the larynx and the sternum, was brought up into the reach of forceps and extracted by Sir W. Savory. Death took place two days later, there being perforation of the end of the pharynx, with suppuration in the neck, mediastina, and left pleura.

† The left side is preferable, as the œsophagus lies more to this side, and as operating on the left side allows of freer movement of the right hand, while the left is at liberty to move the larynx, &c.

‡ If the neck is very stout, or if the parts are swollen, &c., the incision may be from just below the angle of the jaw to close to the sternum.

If the foreign body cannot be felt‡ projecting in the œsophagus—*e.g.*, behind the cricoid—the mouth should be opened with a gag, and a bougie or probang passed, as the flaccid tube-walls are naturally in contact. When the œsophagus lies unusually deep, following round the thyroid or cricoid cartilage with the finger will find it.

When the site of the foreign body has been made out, or when, failing this, it is decided to open the œsophagus low down and to pass probes, &c., a clean incision must be made as far back as possible, so as to avoid the recurrent laryngeal filaments.§

When the tube has been opened, and any bleeding from its walls arrested, the opening is dilated by dressing-forceps, by a probe-pointed bistoury, or by curved forceps passed from the mouth and expanded in the wound. Even after a free opening has been made it may be impossible to dislodge the body, if this, a tooth-plate, has projecting clips, or if it is tightly embraced by the contraction of the œsophageal fibres. In such a case the body should be (if a tooth-plate) divided with bone-forceps and removed in two portions, care being taken to keep hold of each portion with forceps (Lawson, *Clin. Soc. Trans.*, xviii. 292).

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* The anterior jugular vein may give trouble, and should be drawn aside, or divided between two catgut ligatures.

† The larynx should not only be drawn to the right, but tilted over to this side also, as this brings up the œsophagus.

‡ It must always be remembered that the precise site of the foreign body is not always marked by any external swelling or resistance, nor by accurately referred pain; furthermore, bougies occasionally give very slight indications of the presence of bodies (even rough ones) in the œsophagus or pharynx.

§ Mr. Cock (*Guy's Hosp. Reports*, 1868, p. 3) draws attention to this point. Both his patients were in the habit of singing; in the first case (*Ibid.*, 1858, p. 229) a fine tenor voice was replaced by a bass; in the second, in which the œsophagus was opened farther back, the voice did not suffer.

If, after exposing the œsophagus, the body cannot be felt, which will rarely happen, metallic probes or soft bougies should be passed through the wound in the œsophagus, and the lower cervical, and the upper thoracic, portions of this tube carefully explored. The question may now be considered:—How far down from the œsophagus can a body be extracted? The most accessible part is no doubt its junction with the pharynx, opposite to the cricoid cartilage, and the first two inches below this point. Mr. Cock (*loc. supra cit.*) writes: "It might even be possible to extract a foreign body from the early thoracic portion, provided it could be reached with the finger, and thus brought under the influence of a pair of curved forceps."*

As far as my knowledge goes, the lowest point from which a foreign body has been removed occurred in the practice of Mr. Bennet May. Here a child, aged seven, had swallowed a half-penny three and a half years before. The coin had ulcerated through the œsophagus and opened the right bronchus, lying partly in this and partly in the œsophagus. It was removed successfully by œsophagotomy. When the foreign body has been removed, the question of introducing sutures into the œsophagus will arise. These should only be used when the wound in the gullet is clean cut, not bruised, and when the body has been quickly removed: the sutures should be of fine chromic gut and only the upper part of the wound in the œsophagus should be closed, the rest being left open to the bottom to allow of free drainage, owing to the danger of sloughing, pent-up foul secretions, and blood-poisoning (p. 473).† A drainage-tube should be inserted to the bottom of the wound, iodoform dusted on, a few sutures placed in the edges of the wound, dry dressings applied—viz., iodoform gauze, salicylic wool, &c., if the wound has not been much probed about, and there is thus good reason to expect early union. But if ulceration of the soft parts has been found, if they are inflamed, emphysematous, &c., the wound should be left open, drained to the very bottom, and lint soaked in hot saturated boracic-acid solution applied and frequently wetted.

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* The proximity of important parts to the thoracic portion of the œsophagus is well known. Thus, in *Path. Soc. Trans.*, vol. xix. p. 219, is recorded the case of a man who swallowed a bone which lodged in the œsophagus opposite to the arch of the aorta. Death took place suddenly on the fifth day from perforation of the aorta and hæmorrhage, after a slight exertion. Mr. Eve (*Clin. Soc. Trans.*, vol. xiii. p. 174) gives a case in which a fish-bone, impacted in the œsophagus, wounded the heart fatally. It was thought that the position of the fish-bone was perhaps due to previous use of the probang.

† If there is any doubt, sutures had far better be dispensed with. Dr. Barton (*Ann. of Surg.*, July 1887) has recorded a case of successful œsophagotomy in a little child—the age does not appear to be given. The foreign body, a small steel roller of a sewing-machine, had been swallowed three months before. This was extracted through a very small opening in the œsophagus "after the

After-treatment.—If the patient is in good condition, if the foreign body has been removed early, or if the patient has been able to swallow liquids in the interval between the accident and the operation, he may be fed for the first few days by nutrient enemata and nutrient suppositories,* and only a little ice given occasionally by the mouth. But if the strength is not satisfactory at the time of the operation, or if the enemata are not retained, a soft feeding tube must be made use of. This should be passed by the mouth and retained, if not very uncomfortable to the patient, or passed at intervals.† Towards the end of the first week, perhaps earlier, if the wound is healing well, the patient may be allowed to swallow a little diluted wine or milk.

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manner of working a stud through a button-hole which is too small for it," from the fear of causing a fistula if the opening was enlarged. The wounds in the œsophagus and superjacent parts were separately sutured. Epileptic fits soon followed, and frequent vomiting tore open the wound. The fits having ceased with the administration of potassium bromide, the wound in the œsophagus was pared and sutures re-applied as before. This limited much the escape of fluids through the wound, but did not entirely stop it. The passage of a tube through the mouth twice a day caused so much irritation that it was abandoned, and the tube passed through the wound. The wound healed slowly though surely. Dr. Barton is inclined to recommend this way of feeding when primary union is not secured.

* Of these, the zyminized meat suppositories of Burroughs & Wellcome are amongst the best.

† Dr. Markoe (*Ann. of Surg.*, September 1886), in the case of a man, aged twenty-four, from whom he removed, by œsophagotomy, half a tooth-plate, which had been broken in eating, passed a soft india-rubber tube into the stomach through the wound, replacing this by one passed through the nose on the tenth day, and allowing the patient to swallow on the seventeenth day after the operation. The following are the reasons given for passing the tube through the wound:—(1) It ensures good drainage from the bottom of the wound; (2) anything regurgitated from the stomach passes through the tube, not up into the wound; (3) It is less unpleasant. The above reasons do not seem to me to outweigh the great risks and disadvantages of irritating and keeping open the wound, which it is desirable to have closed as soon as possible. As a rule, the tube should certainly be passed from the mouth or nose. It is noteworthy that in the above case the prolonged lodgment of the foreign body—six to seven weeks elapsing between the accident and the operation—had not caused any serious abrasion, &c.

Chief Difficulties.

1. A fat, short neck.
2. Enlarged veins.
3. Wide depressors of hyoid bone.
4. Enlarged thyroid gland.
5. Unusual depth of œsophagus.
6. Detecting the site of the foreign body.
7. Firm gripping of the body by the œsophagus.

8. The foreign body may be dislodged during the operation. Dr. Lediard (*Clin. Soc. Trans.*, vol. xviii. p. 297) records the case of a man in whom emetics and several attempts at removal had failed to dislodge a tooth-plate, emphysema of the neck was present, and some blood on the forceps used. Just before œsophagotomy, a bougie was thought to "scrape" as it was withdrawn. Nothing being felt when the œsophagus was exposed, a bougie was passed, and the œsophagus incised behind the cricoid cartilage; the finger now could feel nothing, and a bougie passed on seemed to feel the plate near the stomach. The plate was passed nineteen days after its impaction; it measured 1½ inches by ¾ inch, carried one incisor, and had "numerous sharp points, and a formidable looking hook at one end." Though there were no laryngeal symptoms, the plate must have been lying behind the lower end of the larynx, as the mucous membrane of the gullet showed here several ecchymoses. The dislodgment of the plate took place either during the passage of the bougie, or in the administration of the anæsthetic. The patient made a good recovery.

Causes of Death.—These are chiefly:

1. Septicæmia.* The wound having become emphysematous, sloughy, and the discharge most foul.

2. Exhaustion. When the body has been long impacted, and the patient's health has run down before the operation.

ŒSOPHAGOSTOMY.

This has been proposed as a substitute for gastrostomy. Mr. Reeves, who brought this subject before the Clinical Society,† recommended this operation as less dangerous than gastrostomy, and in the belief also that cancer of the œsophagus is most frequently met with in the upper part of the tube.* The objections, however, are so great as to have prevented any adoption of this operation. They are—(1) the risk of coming close to a mass of cancer, which will not only not admit of dilatation, but which will be rendered more active, sloughy, &c., by the necessary irritation. (2) The fact that important parts are close by, and that the relations of these may very likely be much altered. (3) The probability of finding the œsophagus altered near the disease, and thus, perhaps, readily perforated, admitting fluids into the pleura, &c.

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* Mr. Butlin (*Clin. Soc. Trans.*, vol. xvii. p. 129) relates a case in which a tooth-plate was removed within twenty-four hours of its being swallowed, previous attempts at removal, lasting thirty or forty-five minutes, having failed. No difficulty was experienced during the operation, but the patient sank from septicæmia four days after the operation. He was allowed to swallow on the second day, about a third of what was taken coming through the wound. Mr Butlin considered this beneficial, as conducing to drainage. The wound was thoroughly washed with carbolic lotion and covered with carbolic oil. Two days after, the wound being very offensive, the dressing was altered to sanitas, changed every four hours.

† *Trans.*, vol. xv. p. 26.

ŒSOPHAGECTOMY.

This is another operation which has been introduced only to be abandoned. Prof. Czerny's case, it is true, was temporarily successful, the patient living rather more than a year after the operation. But cases equally suitable from the site of the disease —only just out of reach of the finger introduced from the mouth —with no glands involved, and no adhesions to adjacent parts, though symptoms had lasted five months, must be quite exceptional. Several of the risks given above would be intensified here, and there would be present as well the need of keeping the fistula patent.†

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* Most surgeons who have been called upon to pass bougies in these cases will agree with Dr. Goodhart, who, in the discussion on the above paper, said the disease usually extended from the cricoid cartilage nearly to the pylorus.

† Mr. Butlin (*Oper. Surg. Malig. Dis.*), to whom I am indebted for Prof. Czerny's case, gives one of Prof. Billroth's, where death was caused by the passage of the bougie into the tissues round the œsophagus, the opening where the lower end of the œsophagus had been stitched to the skin having contracted.

CHAPTER XVI.

OPERATIONS ON THE SPINAL ACCESSORY NERVE.

PARTIAL NEURECTOMY, OR NERVE-STRETCHING.

Indications.—In cases of spasmodic torticollis in which

1. All previous palliative treatment has failed—*e.g.*, large doses of conium, massage, galvanism of the affected side, and faradisation of the opposite muscles.

2. The spasms are so severe and constant as to interfere with the patients taking food or enjoying sleep, and to cause sad weariness and real suffering.

3. The only muscles affected are the sterno-mastoid, or the sterno-mastoid and trapezius.

Anatomy of Spinal Accessory Nerve.—The spinal or external part of this nerve, having left the skull by the jugular foramen, is directed backwards in front of, or behind, the internal jugular vein, and appears below the digastric and the occipital artery. It then descends obliquely outwards to the sterno-mastoid muscle, and disappears under this at a distance of 2 inches from the apex of the mastoid process. Having usually perforated the muscle, the nerve passes across the posterior triangle to end in the deep surface of the trapezius. While passing through or under the sterno-mastoid the nerve joins with branches from the second cervical. Having emerged from the muscle, it joins with the second and third nerve, and is often in intimate connection with the great auricular and small occipital. When under the trapezius it is joined by branches of the third and fourth cervical.

Operations for Partial Neurectomy, or Stretching of the Nerve.—These may be considered together, but it may be said, once for all, that, as stretching will be followed by but temporary benefit, division of the nerve will be the better operation.

The nerve may be found by two different incisions.

A. Along the anterior border of the sterno-mastoid so as to come upon this nerve before it perforates this muscle.

B. Along the posterior border of the muscle, the surgeon finding the nerve as it emerges here to cross the posterior triangle to gain the trapezius, and following it up above its branches to the sterno-mastoid, so as to paralyse this muscle also.

The first of these operations is in my opinion much preferable, and for these reasons:—

1. Though the nerve lies more deeply at the anterior than at the posterior border of the muscle, it is here a single nerve, and not likely to be confounded with other nerves—*e.g.*, branches of the third cervical, which also emerge at the posterior border to supply the skin. Furthermore, in this latter position, the spinal accessory is often found in close connection with the small occipital and great auricular, as these two nerves appear at the posterior border and curve upwards.

2. By finding the nerve at the anterior border of the muscle paralysis of the sterno-mastoid is better ensured. When the nerve is found at the posterior border and followed up into the muscle before division, there is always an uncertainty as to whether some branch to the muscle may not have come off above the point at which the surgeon has divided the nerve.

A. **Operation above Sterno-mastoid.** — The parts being shaved and cleansed, and the head suitably raised and turned to the opposite side, the surgeon makes an incision along the anterior border of the sterno-mastoid for 3 inches, commencing at the apex of the mastoid process. Skin, fasciæ, and platysma being divided, the anterior border of the sterno-mastoid is clearly defined and drawn strongly backwards, so as to put the nerve on the stretch; the wound being sponged out dry, the nerve is found, and from $\frac{1}{4}$ to $\frac{1}{2}$ inch removed.

If there is any doubt about finding or identifying the nerve, the following aids may be found useful—viz., defining the lower border of the digastric and the occipital artery, remembering the direction of the nerve, and looking for it at a point 2 inches below the apex of the mastoid process.*

B. **Operation Below or at Posterior Border of Sterno-mastoid.**—Mr. Campbell de Morgan, who introduced this operation into British surgery with a very successful case,† made an incision, 2 inches long, along the posterior border of the sterno-mastoid, the centre of the incision corresponding to about the centre of this border of the muscle. The fascia being slit up to the same extent, the trapezial branch of the nerve was sought for as it emerges from the sterno-mastoid to cross the posterior triangle. It will be found generally a little above the centre of the wound; when found, it is traced through the muscle till the common trunk is discovered above its division into branches for the trapezius and sterno-mastoid. Half an inch of the nerve is then cut out,

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* Ballance, *loc. infra cit.*

† *Brit. and For. Med.-Chir. Rev.*, July 1866. I performed the same operation on a middle-aged woman about thirteen years ago at Guy's Hospital in a very severe case of spasmodic torticollis. The right sterno-mastoid and trapezius were paralysed and rendered quiescent, but some of the deeper muscles on the opposite side—viz., the splenii—became affected, and no permanent benefit resulted.

If called upon to perform this operation again, I should certainly prefer the first of the two methods given above, as being more certain, and as not really more difficult. Though the nerve is more superficial in the posterior triangle, it is difficult to make certain whether it is the spinal accessory or one of the superficial cervical nerves which emerge close to it, from behind the muscle (p. 476).

The most interesting contribution to the literature on this subject is a paper by Mr. Ballance.* His patient, a woman of forty-eight, was a good instance of the distress and misery due to spasmodic torticollis. Division of the right spinal accessory in the anterior triangle gave most decided relief. At the end of four months, when the history ceases, the patient is reported to have been "much better and stouter. The face is happy and tranquil. There is neither headache nor pain, and sleep and appetite are good. The control of the movements of the head is perfect as long as she is not excited, and so long as the head is not raised so that the eyes are directed much above the horizontal plane in which they lie. . . . . The right sterno-mastoid and trapezius are atrophied."

Division of the spinal accessory deserves a further trial, even if the relief given is not permanent.

The chief fear is that other muscles will become involved, as in my case. Thus, Mr. Ballance writes of his case: "Since the operation, it has been certain that some of the muscles supplied by the upper spinal nerves are liable to spasm. It would be strange if it were not so, considering the intimate connections between the second, third, and fourth spinal nerves, and the spinal accessory in the sterno-mastoid, trapezius, and posterior triangle, together with the fact that some of the fibres of the spinal accessory are connected with the same cells, or with cells in the immediate neighbourhood of those from which arise the motor rootlets of the cervical spinal nerves."

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* *St. Thomas's Hosp. Reports*, vol. xiv. p. 95. Other successful cases will be found recorded by Prof. Annandale (*Lancet*, 1879, vol. i. p. 555) and by Mr. Southam (*Ibid.*, 1881, vol. ii. p. 369); Mr. Rivington also operated (*Ibid.*, 1879, vol. i. p. 213), but phlegmonous erysipelas carried off the patient before the wound was quite healed.

CHAPTER XVII.

LIGATURE OF THE ARTERIES OF THE HEAD AND NECK.*

LIGATURE OF THE TEMPORAL ARTERY (Fig. 102).

Indications.—These are very few, viz. :

1. Wounds—*e.g.*, stabs and gunshot injuries.

2. Aneurism, usually traumatic. Mr. Skey (*Oper. Surg.*, p. 289) met with a case of aneurism of doubtful origin in this artery in a young lady. Ligature of the vessel below having failed, he cured his patient by means of a fine spring compress with a ball-and-socket joint which, passing over the head, entirely concealed by the hair, made pressure on the tumour.

Aneurisms have been known to occur here after the operation of arteriotomy.

GUIDE.—A line drawn upwards over the root of the zygoma, midway between the condyle of the jaw and the tragus.

RELATIONS.—Given off behind the jaw, this vessel passes up midway between the above two points over the zygoma, and at a point 1½ or 2 inches higher up it divides into its anterior and posterior branches. Lying at first in the parotid gland, it is covered a little higher up by a dense fascia passing from the parotid to the ear, by the attrahens aurem, often a lymphatic gland, and one or two veins which lie superficial but close to it. Some branches of the facial nerve cross it, while the auriculo-temporal nerve accompanies it closely. Higher up, the artery and its branches are particularly subcutaneous.

Operation (Fig. 102).—The parts being shaved and cleansed, the head fitly supported and turned to the opposite side, an incision about 1 inch long is made in the line of the artery so as to tie it just above the zygoma. The dense subcutaneous tissue and the strong parotid fascia being cleanly divided, the artery must be accurately defined, and the vein being drawn to one side, usually backwards, the ligature should be passed from behind forwards, care being taken to include only the artery.

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* Ligature of the thyroid arteries has already been considered, chap. xiii. p. 454.

Arteriotomy.—A few words may be said here about this seldom-used operation. The surgeon, having defined the anterior division of the temporal, steadies the vessel by placing his finger just beyond the point which he intends to open, and then with a small sharp scalpel lays open the vessel till it is about half cut through. The blood required having been removed, he divides the vessel completely, so as to allow the ends to retract, applies a pad of aseptic gauze or of lint and iodoform, and retains this in position with the twisted or knotted bandage for the head. The pad should not be removed for four or five days.

The reasons for preferring the anterior division to the trunk of the vessel are the following :—

(1) The latter lies much more deeply, under fasciæ, and in the parotid below; thus so much pressure may be required to stop the bleeding as to cause sloughing, secondary hæmorrhage, and dangerous erysipelatous inflammation.

(2) Injury to one of the adjacent nerves may cause severe pain and tedious healing.

(3) From opening a vein at the same time an arterio-venous aneurism may result.

LIGATURE OF THE FACIAL ARTERY (Fig. 102).

Indications.—These are much the same as, but still fewer than, those for ligature of the temporal artery.*

The vessel's course is divided into a cervical and a facial part.

Cervical Part.—Ligature here can be scarcely ever required. The vessel could be reached here by an incision similar to that for the external carotid (p. 514) or the lingual (p. 484). In either of these cases the vessel would be found just below the posterior belly of the digastric and the stylo-hyoid, these muscles being drawn upwards to enable the surgeon to tie the vessel just before it enters the sub-maxillary gland.

RELATIONS IN THE NECK.—The facial artery is given off just above or in connection with the lingual, about an inch above the bifurcation of the common carotid. It ascends upwards and inwards to the lower jaw, being covered by skin, fasciæ, and platysma, the digastric and stylo-hyoid, and being embedded in the sub-maxillary gland, to which structure the vein lies superficial. The tortuous outline of the vessel is well known. The vein, running a straighter course, lies posterior to the artery.

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* The reader is advised to take every opportunity afforded upon the dead body to tie these and other arteries, though apparently so small and unimportant, as only by such practice can dexterity be really acquired.

Facial Part.—The artery is readily secured by a small horizontal incision just below the jaw in front of the masseter muscle, the anterior border of which should be first defined, this being easily done on the living subject by telling the patient to throw it into action. The incision should be made carefully, so as to avoid any branches of the facial nerve which may lie in the way. The artery will now be felt when rolled upon the bone by a finger; the ligature should be passed from behind forwards so as to avoid the adjacent vein.

LIGATURE OF OCCIPITAL ARTERY (Fig. 102).

Indications.

1. Stabs.

2. Gunshot wounds. In the *Medical and Surgical History of the War of the Rebellion*, part i. p. 422, two cases are given of secondary hæmorrhage after wounds of the neck, in the one case from the occipital, in the other from a branch of it; in the former case 16 ounces of blood were lost. The vessel was tied in the wound in each case, two ligatures being, of course, applied.

3. In the treatment of arterial varix, cirsoid aneurism, or aneurism by anastomosis on the head (p. 509).

4. For hæmorrhage from an abscess in the neck. Mr. Banks* has published a most instructive case. A weakly man, aged thirty-two, had had a suppurating gland incised three weeks before admission. Poultices were applied, and, a week after, during a violent attack of coughing, blood burst from the wound "like a tap being turned on." Three times afterwards hæmorrhage ensued, pressure being applied in vain. On admission he was in the last stage of exhaustion. The right side of the neck from ear to clavicle was occupied by a great fluctuating swelling. In front of the sterno-mastoid, about half-way down, was the original incision, from which a little sanious discharge was issuing. Behind the muscle a piece of skin about an inch square was actually sloughing from the subjacent pressure. Under ether, and in a good light, the original incision was enlarged upwards and downwards, and a quantity of putrid broken-down clot turned out. Then a similar incision was made behind the

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* *Clinical Notes upon Two Years' Surgical Work at the Liverpool Royal Infirmary*, p. 161.

sterno-mastoid through the sloughing skin. Everything being mopped and cleaned up, blood was found to be trickling down from somewhere very high up. To get at it, the sterno-mastoid and skin over it were cut clean across, thus uniting the two vertical incisions by a transverse one. The muscle was dissected upwards, exposing the sheath of the carotid vessels, but still the blood always kept running from some deep-seated point high up. At last this was reached, just in front of the transverse process of the atlas. From it arterial blood issued, and an aneurism needle was thrust through the tissues on each side of it and ligatures applied, which at once checked all further bleeding. The vessel was the occipital artery not far from its origin. Into it the abscess had made its way. The great wound was rapidly swabbed out with turpentine and then stuffed with lint dipped in the same. The patient was very near to death's door, but ultimately recovered.*

RELATIONS.—A posterior branch of the external carotid, the occipital comes off opposite to or a little above the facial, just below the digastric. It at first ascends, having the ninth nerve hooking round it, under the digastric, stylo-hyoid, and parotid, and crossing the internal carotid, internal jugular, vagus, and spinal accessory. Having reached the interval between the transverse process of the atlas and the mastoid bone, it now, in the second part of its course, turns horizontally backwards, grooving the temporal bone, covered by the sterno-mastoid, splenius, digastric, and trachelo-mastoid, and lying on the complexus and superior oblique. In the third part of its course it runs vertically upwards, piercing the trapezius, and ascending tortuously in the scalp.

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* Such was the patient's condition that the surgeon was quite prepared for his dying under the operation. The following characteristically vigorous words conclude the account:—"But I was determined as long as he had any blood to run out of him, the place whence it came should be found and tied." In connection with this case may be quoted, in his own words, some remarks of Mr. Banks on the value of turpentine as a cleansing styptic. This remedy has again lately been recommended, and it is only fair that Mr. Banks should have the credit of having recognized its value many years ago. "In former days it was the regular thing for oozing, until superseded by the introduction of perchloride of iron. This has always seemed to me most unfortunate, as iron is the very worst of all styptics. Owing to its great potency and the rapidity with which it acts, it soon became popular, and is at the present moment the favourite standby of the chemist, who diligently swabs with it every cut that is brought into his shop, preparatory to sending the patient off to a hospital. As a result, the wound is covered with a cake of coagulated blood, and its surfaces are sometimes positively killed by the strength of the application. Beneath this firmly adherent crust all sorts of purulent, filthy secretions accumulate, till at the end of forty-eight hours it stinks abominably, and requires to be well poulticed to get it clean. Should bleeding recur, the difficulty of finding the spot is enormously increased by the mass of pus and almost cineritious hard clots which cover it. I have seen so many cut hands almost ruined by it that I have totally abandoned it. On the other hand, turpentine is nearly as powerful a styptic, and is a most marvellous cleanser and sweetener. The plug soaked in turpentine comes out quite easily at the end of four-and-twenty hours, leaving a wholesome surface behind it. For all wounds about the perinæum, such as lithotomy wounds, fistula, cuts, or incisions for extravasation of urine, there is nothing like it, and I trust it will soon be reinstated in surgical favour. Our forefathers had some excellent remedies, and this is one of them." I have used sal alembroth gauze soaked in turpentine, with excellent results, after removal of a most fetid discharging pyonephrosis. Only the gauze, &c., *in* the wound must be thus soaked.

Operations.

1. If the artery require securing low down, this may be effected much as in tying the external carotid, an incision being made along the anterior border of the sterno-mastoid, the deep fascia opened, and the digastric and ninth nerve exposed. Care should, of course, be taken to avoid the latter.

2. To tie the artery behind the mastoid process (Fig. 102), *e.g.*, when it has been wounded by a stab in the neck, the following steps should be taken :—The parts being shaved, and the head at first being placed in much the same position as for ligature of the carotids, an incision is made from the tip of the mastoid process rather obliquely upwards, so as to lie over a point midway between the mastoid and external occipital protuberance. The tough skin and fasciæ being incised, the posterior half of the sterno-mastoid, with its strong aponeurosis, and next the splenius capitis, must be divided, together with any fibres of the trachelo-mastoid that are in the way. The wound being somewhat relaxed by turning the head over to this side, retractors deeply inserted, and a laryngeal mirror used if needful, the artery will be found deep down between the mastoid bone and the transverse process of the atlas.

In separating it from its vein, one or more veins varying in size may be met with, forming communications between the occipital and mastoid veins, and thus with the lateral sinus. The wound should therefore be kept rigidly aseptic.

LIGATURE OF THE LINGUAL ARTERY (Fig. 98).

Indications.

1. Before removal of the tongue. This subject has been considered at p. 368.

2. After removal of the tongue, to arrest hæmorrhage.

3. In cases of tongue cancer not admitting of operation, in the hope of checking the rate of growth, diminishing the fœtor, profuse salivation, &c. This step is uncertain as to the amount of good which it effects, and any good that it may do will not be long lived.*

4. In cases of macroglossia this operation may be tried before removing a wedge-shaped piece of the tongue; it would require to be performed on both sides, and would be attended with considerable difficulty in a child.

RELATIONS.—The lingual artery arises about ¼ inch above the superior thyroid, often in common with the facial, and at a point opposite to the great cornu of the hyoid bone. It first ascends to a point rather above the level of the hyoid bone, then descends somewhat and runs just above the great cornu, and finally, ascending to the under-surface of the tongue, it runs forward with a tortuous course to the tip as the ranine.

For practical purposes the relations of the artery may be subdivided into **three parts**—the **first** before it gets under the hyo-glossus, the **second** while it lies beneath this muscle, and the **third** beyond this muscle.

In **the first** it runs very deeply, though only covered by the skin, platysma and fasciæ, facial, lingual, and some pharyngeal veins; it lies upon the middle constrictor and the external laryngeal nerve.

In **the second part** of its course the artery again lies upon the middle constrictor, and is now covered by the hyo-glossus, hypo-glossal, part of the mylo-hyoid and the lower border of the sub-maxillary gland. From this part come off the four branches of the artery, the hyoid at the outer or posterior edge of the hyo-glossus, the dorsalis linguæ under this muscle, and the sub-lingual and ranine at its anterior border, thus allowing room for placing a ligature.

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* Mr. Haward (*Clin. Soc. Trans.*, vol. x. p. 129) related a case in which he tied the left lingual artery for recurrent epithelioma. The recurrent growth was the size of half a walnut when the lingual artery was tied. It at once ceased to grow, became pale, and in a few days was sloughing. Gradually separation of the growth went on, until the affected side of the root of the tongue became even smaller than the sound side, and eventually the part healed. A fortnight after this took place, or three months after the ligature of the artery, the patient died of pyæmia, set up by erysipelas coming on after the operation. Mr. Haward pointed out that the greater part of the tongue had been removed before the ligature of the lingual, so that therefore the anastomoses between the arteries of the two sides would be greatly diminished. I think, also, that the fact that Mr. Haward was obliged to tie the artery close to the external carotid may have contributed to the sloughing, by cutting off the entire blood-supply, especially that through the dorsalis linguæ.

On the other hand, Billroth (*Clin. Surg.*, p. 113) states that, in one case of cancer of the tongue, "the lingual artery was ligatured on both sides, in the hope that the infiltration of the tongue in the cavity of the mouth might diminish. However, the ligature led to no good results, nor did any rapid breaking-down of the already ulcerated new formation occur."

The third part lies in the mouth, and runs along the under-surface of the tongue up to the point of the frænum. It is only covered by mucous membrane. A vein runs with it, and a large branch of the gustatory nerve.

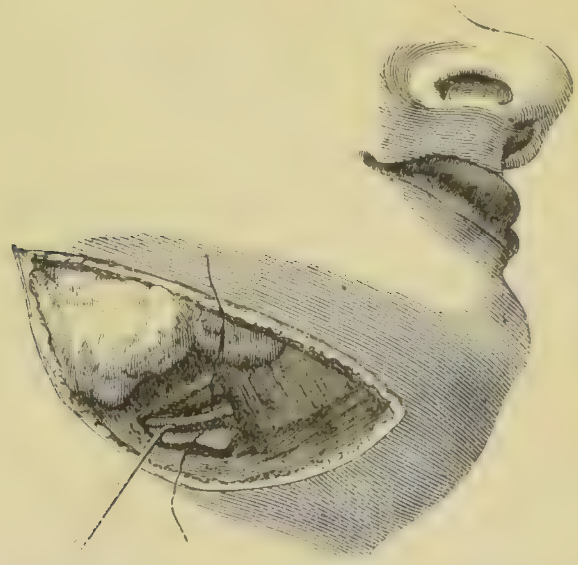
Operations.

i. **Ligature under the Hyo-glossus.**

ii. **Ligature of the first part of the Artery.**

i. The vessel is usually tied while **under the hyo-glossus muscle,** owing to the useful guide which the great cornu of the hyoid bone forms, and this is the operation which will be described here (Fig. 98). Under some circumstances (p. 486) it will be needful to seek it nearer its origin from the external carotid. The parts being shaved, the head suitably supported and turned to the opposite side, and the lower jaw firmly closed, the surgeon, standing or seated on the same side, steadies the tissues between his left finger and thumb, and makes a curved incisio with its centre just above the great cornu of the hyoid bon (a point previously carefully noted), and reaching, *e.g.*, on the lef

FIG. 98.*



The sub-maxillary gland is seen in the upper part of the wound. Below this is the hypo-glossal on the cut hyo-glossus. A ligature is passed between the lingual artery and vein. A hook depresses the great cornu of the hyoid bone. The lower part of the hyo-glossus is reflected. Lowest of all is the digastric.

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* The lingual artery is here drawn too large, and too much of the vessel i shown cleaned; the depth of the wound is not sufficiently represented.

side, from just below and to the left of the symphysis downwards, backwards, and then upwards towards the angle of the jaw, ending just anteriorly to the line of the facial artery.

The incision divides skin, superficial fascia, and platysma; the deep fascia is then opened and any branches of the anterior jugular, facial, or communicating branch with the temporo-maxillary vein are secured carefully, so that the wound may be kept as dry as possible. The lower border of the sub-maxillary gland, which probably projects into the wound, is turned upwards* and the hypo-glossal nerve sought for, which lies deeper, and is a good guide to the hyo-glossus. Lower down in the neck is the glistening tendon of the digastric attached to the hyoid bone. The hyo-glossus being defined, the hyoid bone is carefully steadied by a finger-nail or tenaculum, a director passed under the hyo-glossus, and this muscle divided cautiously. In doing this the lingual vein must be carefully looked for either on the muscle or beneath it, with the artery. The artery having been found under the muscle just above the hyoid bone, it should be traced backwards so as to apply, if possible, the ligature behind the origin of the dorsalis linguæ. Adequate drainage must be provided, and every care taken to prevent decomposition in a wound so deep, and opening up several planes of deep cervical fascia.

Any enlarged glands will of course be removed.

Guides and Aids to finding the Artery.

1. A sufficiently free incision.
2. Carefully defining the hypo-glossal nerve, and remembering the relative position of the sub-maxillary gland, the digastric tendon, and the great cornu of the hyoid bone.
3. Keeping the wound bloodless.

Difficulties.

1. Matting of the parts from old cellulitis.
2. Presence of large veins.
3. Depth of the wound, and oozing low down from the severed hyo-glossus.
4. In one case Dr. Shepherd (*Annals of Surgery*, vol. ii. No. 11, p. 359) found the digastric so extensively tied down to the hyoid bone by the deep cervical fascia as to require separation.
5. The position and condition of the lingual vein alike is

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* The sub-maxillary gland should be gently handled, and not cut into. In the one case troublesome swelling, in the other temporary weeping of saliva, or even a fistula, will be the result.

at times perplexing. Usually it lies on the hyo-glossus; occasionally it lies under it, with its artery. Billroth (*Clinical Surgery*, p. 113), who has tied the lingual artery twenty-seven times, tied the vein for the artery in one case, as was verified post mortem. "Every surgeon knows the difficulty of tying the lingual artery in old people; the vessel lies so deep that it is very difficult to distinguish it from thick-coated distended veins, especially when, owing to heart disease—as in this case—the veins pulsate. Never previously had I met with a lingual vein of such thickness."

6. Abnormal position of the lingual artery itself. This is rare, but the artery may lie higher than usual; it may pierce the hyo-glossus; occasionally, one lingual is minute or absent.

7. The sub-maxillary gland may be unusually large and occupy much of the space between the jaw and the hyoid bone.*

ii. If the vessel cannot be found on the hyo-glossus, or if the condition of soft parts is such, owing to cellulitis, matting, or enlargement of glands, as to prevent any attempt being made here, the surgeon must cut down upon the **first part** either by an incision similar to the above but less curved, and running from the centre of the hyoid bone just above the great cornu to the anterior border of the sterno-mastoid, or by one similar to that used for ligature of the external carotid, with its centre opposite to the hyoid bone.

Difficulties.

1. There is no certain guide to the artery here.

2. The artery itself is not constant in position here, varieties occurring frequently in the height at which it comes off from the external carotid, whether alone, or in common with the facial.

3. Large veins—*e.g.*, the lingual and facial—will certainly be present.

LIGATURE OF THE COMMON CAROTID
(Figs. 100, 101).

Indications.

1. Wounds of the trunk itself. Owing to the rapidly fatal issue of such injuries, the surgeon is not often called upon to meet them.† Cases calling for ligature for wounds of the trunk may

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* Dr. Shepherd, *loc. supra cit.*, p. 361.

† These, in reality, rare wounds of the common carotid might, at first sight, be thought to be more common, owing to the inaccuracy with which wounds of the external carotid have been quoted as those of the common trunk.

be grouped as follows :—(*a*) For immediate hæmorrhage ; (*b*) for secondary hæmorrhage ; (*c*) for gunshot injuries.

(*a*) *For Immediate Hæmorrhage.*—Ligature of the common trunk is here rarely called for, as above stated. In civil practice, such cases may occasionally occur in cut-throat. If the surgeon arrives in time, he should arrest the hæmorrhage, while waiting for assistance, by thrusting one or more fingers into the wound and making pressure on the bleeding-point, remembering that but slight force is required if the pressure is on the right spot. If the patient has to be removed any distance, finger pressure must be kept up or the wound plugged with carbolized sponge or aseptic gauze, and the head kept rigidly still. Pressure with a finger or with a sponge on a holder should be kept upon the bleeding-point while the wound is enlarged, and the opening in the carotid secured by ligatures placed above and below it.

Mr. Butcher, in a case of suicidal cut-throat implicating the common carotid, successfully ligatured the artery above and below, the patient making an excellent recovery.

While on this subject, I may refer to the following case of Mr. Guthrie's,* which shows that if the carotid is wounded, though not opened, it is best to apply ligatures above and below. In a case of attempted suicide, the cut was deepest on the left side, having laid bare the left carotid and wounded the internal jugular. "The opening into the vein being distinct, I passed the point of a tenaculum through the edges made by the cut into it, and, drawing them together, passed a single silk thread around so as to close the opening without destroying the continuity of the vessel. The ends of the ligature were cut off close to the knot. The carotid was then clearly seen by the side of the vein, having a transverse mark or cut upon it, which did not appear to penetrate beyond the middle coat; and, after due consideration, it was presumed that this wound might heal without requiring a ligature to be placed upon the artery. On the eighth day, arterial hæmorrhage took place, and, on opening the wound, it came evidently from that part of the carotid which had been cut. I placed a ligature upon the common carotid immediately below this opening, but the flow of blood was scarcely diminished in quantity by it, in consequence of the reflux from the head. On attempting to apply another ligature above the opening, I found, as I had before suspected from the situation of the wound, that it was immediately below the division of the common into the external and internal carotids. The hæmorrhage ceased on placing a ligature on the external carotid, and, as the patient was greatly exhausted, I refrained from tying the other. The bleeding did not return, but he died the next morning from weakness." At the autopsy the internal jugular was found pervious and without a mark indicating where the ligature had been applied. The origin of the internal carotid was filled for about ¼ inch with a soft clot, the wound in the common carotid was exactly below its bifurcation, and Mr. Guthrie thought that the ligature on the external carotid might have been sufficient.*

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* *Wounds and Injuries of Arteries*, p. 78.

Mr. Guthrie mentions (*loc. supra cit.*, p. 79) another case in which the common carotid was wounded by a penknife, and the hæmorrhage arrested by tying the vessel above and below the wound.

(*b*) *For Secondary Hæmorrhage.*—A remarkable instance of punctured wound of the common carotid in which the vessel was tied for secondary hæmorrhage is thus recorded by Mr. Durham :†—A child aged nine was wounded with glass, owing to an explosion of hydrogen gas. When admitted into Guy's Hospital, under the care of Mr. Hilton, the child was cold and blanched, but the bleeding, which had been profuse, had entirely ceased. There was a wound about an inch long "in the left carotid region." On the eighth day after the accident hæmorrhage recurred, and the common carotid was tied. Nine days later, slight bleeding took place, but was arrested by plugging the wound with sponge. Repeated epistaxis occurred, which weakened the child perceptibly. The sloughs became very offensive, but there was no further bleeding from the wound for eighteen days, when a considerable quantity was lost. The child gradually sank, and died six weeks after the accident.

At the autopsy the common carotid was found to have been traversed by a sharp-pointed fragment. Behind the wounded vessel was an abscess implicating the sympathetic. Mr. Durham thinks that if a ligature had been applied on the distal as well as on the proximal side, the child's life would have been saved.

Another case of secondary hæmorrhage has been recorded by Mr. Rivington (*Trans. Med. Chir. Soc.*, vol. lxix. p. 63). This paper, like several others by the same writer, is replete with valuable information and interesting facts. It is an excellent instance of the way in which the carotid may at any time be wounded from within, and not from outside, by a foreign body penetrating the pharynx.

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* This would appear very doubtful, owing to the freeness of the collateral cerebral circulation, and the readiness with which a reflux current along the internal carotid is established. See the case given at p. 487.

† *System of Surgery*, vol. i. p. 739.

A boy, aged nine, six days after swallowing a small plaice-bone, was admitted into the London Hospital with stiffness and tenderness of the neck, a small tender lump on the left* side opposite to the cricoid cartilage, profuse salivation, and inability to swallow solid food. On the ninth and eleventh day hæmorrhage took place, on the latter occasion to half a pint. The following account of the operation by which the injured vessel was found and secured will be most instructive to every operating surgeon, owing to the difficulties which presented themselves:—

An incision was made along the edge of the sterno-mastoid for several inches. The muscle was found glued to the subjacent parts by recent adhesions. Above the anterior belly of the omo-hyoid was a dark patch about the size of a fourpenny-piece, caused by extravasated blood looming through the fascia. The fascia over the large vessels being divided, a probe was passed down into a cavity containing clot, hollowed out behind the vessels and on the inner side. Owing to the uniform discoloration of artery, vein, nerves, fascia, and areolar tissue by the extravasated blood, the structures met with, being all dark and equally stained, could scarcely be recognized. The descendens noni could not be seen, nor the vagus distinguished, though carefully looked for. More clots being turned out from the cavity, in one of these the fish-bone was found. A gush of blood which took place, evidently from the distal end, was arrested partly by pressure and partly by pulling forward the vessels with a blunt hook. The wounded vessel being found, a ligature was passed closely, as was thought, around it, both above and below the seat of injury. Owing to the danger of subjecting the patient to a further loss of blood, there was no time to make a prolonged dissection, and it was thought prudent to divide the artery at the seat of the wound to make sure that no branch was given off between the ligatures. When this was done, some nerve fibres were recognized on the cut section, and the question arose whether these were the descendens noni or the vagus. As they were in front of the vessel, closely adherent, and apparently scarcely numerous enough for the vagus, it was concluded that they belonged to the descendens noni, and no attempt was made to disengage the nerve or to unite its extremities. It was proved, later on, that this nerve was the vagus, which, instead of lying between and behind the artery and vein, took, or had been pressed into, an unusual position in front of the artery, and, owing to the inflammation induced by the injury, had become firmly adherent to the vessel for some little distance above and below the aperture in the artery. Externally the nerve was stained of the same dark colour as the artery, and only in the centre, after section, were the white nerve-fibres to be recognized. The patient died ten days after the operation, having shown no evidence of ill-effects from the divided vagus, save perhaps slight cough and difficulty in swallowing. Two gangrenous abscesses in the left half of the brain, which were probably already in progress prior to the operation, were the cause of death.

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* The left common carotid is more exposed to danger from the passing of the œsophagus somewhat to this side.

(*c*) *Division of the common carotid* by gunshot injuries is usually fatal at once, as in two cases recorded in Circular No. 3 of the War Department, Washington, 1871.

2. Aneurism of the carotid. Where an undoubted* aneurism of the vessel exists and is increasing in spite of pressure,† or where this cannot be made use of, the artery should be tied, on the cardiac side of the aneurism if possible, or, failing this, distally.

The Mortality after Ligature of the Common Carotid for Aneurism is as yet high. Thus Mr. Johnson Smith (*loc. supra cit.*), quoting from the tables of M. Lefort,‡ gives twenty-one as fatal out of forty-seven cases of proximal ligature. Mr. Barwell §

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* It is well known that this aneurism is diagnosed more frequently than it is really found to exist, owing to the closeness with which some varicosity of the artery at its bifurcation, glandular and other tumours lying over it, and, in the root of the neck, other aneurisms—*e.g.*, of the innominate, aorta, and subclavian —simulate a carotid aneurism. Few surgeons will, I think, agree with the statement of Mr. Johnson Smith (*Dict. of Surg.*, vol. i. p. 235) that carotid aneurism occurs "about as often as subclavian aneurism, and with greater frequency than aneurism of the axillary artery."

† This may be applied to the artery or the sac, or both. In the former case the artery should be compressed above the transverse process of the sixth cervical vertebra, to avoid making pressure on the vertebral at the same time. If pain, vertigo, sickness, &c., prevent a fair trial of digital pressure, an anæsthetic may be tried, but, as Mr. Barwell points out (*Encycl. of Surg.*, vol. iii. p. 498), there may be much difficulty in deciding how far the syncope, &c., which may be present are due to the anæsthetic or to the pressure. Another means of keeping up pressure on the common carotid is that suggested by Rouge, in which, the sterno-mastoid being relaxed, the surgeon insinuates his fingers behind one border, and his thumb behind the other border, of the muscle, and thus compresses the artery between them.

‡ *Gaz. Hebd.*, 1864 and 1868.

§ *Loc. supra cit.*, p. 502.

considers a little over 25 per cent. to be the mortality in cases of aneurism proper. Whichever of these estimates is correct, in the future the mortality should be much reduced by the advantages of aseptic surgery and modern ligatures. **The chief dangers** to be guarded against are suppuration of the sac and hæmorrhage, brain and lung complications, and hæmorrhage from the site of ligature. These are alluded to more fully below, p. 505.

The old operation for carotid aneurism is described at p. 502.

3. In aneurism of the innominate or aortic arch. The question of the advisability of ligaturing the carotid either together with the subclavian, or alone, especially in the case of the left common carotid, is considered at p. 561.

4. In orbital aneurism, where the symptoms are becoming aggravated, or where pressure has failed, or where it cannot be endured, even intermittently, for a few minutes only at a time, and where galvano-puncture and injection of coagulating fluids are set aside owing to their uncertainty and riskiness.*

Of the fifty-three cases (Rivington, *loc. supra cit.*), viz., twenty-one idiopathic and thirty-two traumatic, in which the common carotid was tied, thirteen of the former were cured and seventeen of the latter. The above writer, speaking of this mode of treatment, says it is "at present the most successful and satisfactory means of treating orbital aneurism. It should not be practised on patients advanced in years, or on those with heart disease, or evident atheromatous degeneration of arteries."

5. In aneurism of the external or internal carotid. These are very rare. Two cases of aneurism of the former vessel have been recently published. Mr. Morris † recorded one in which, after failure of ligature of the common carotid, the old operation of incising the sac was performed, and ligatures placed on the facial and lingual arteries, and upon the main trunk of the external carotid above the sac, with ultimate recovery.

The second case was published by Mr. Heath ‡ in order to prove that ligature of the common carotid alone is sufficient to cure some cases of aneurism of the external carotid.

The occurrence of aneurism here in a woman, aged twenty-three, was accounted for by the state of the cardiac valves and the liability for embolism to occur in consequence of detachment of a vegetation. There was a smooth, round, pulsating swelling just below the right mastoid process, reaching down to about the level of the upper border of the thyroid cartilage. It had the size and shape of half a small orange. The right tonsil was somewhat pushed inwards, the right temporal pulse was markedly weaker than the left, and the tongue deviated much to the right, the right half being a good deal wasted. The common carotid was tied and the wound healed, pulsation in the aneurism had stopped on the tenth day, and on the eighteenth the sac was smaller and quite hard. All seemed to be doing well till the thirty-third day after the operation, when loss of speech occurred somewhat suddenly, followed by right hemiplegia, and death on the thirty-fifth day, this being brought about by cerebral embolism taking place through the *left* carotid, the aneurism being solidified throughout.

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* Mr. Rivington (*Dict. of Surg.*, vol. ii. p. 131) speaks thus of injection:—"It is more painful than ligature, and probably involves more risk to vision, as it may set up inflammatory mischief in the loose areolar tissue around the veins, which may spread to the cornea. It may also effect so much coagulation as to interfere with the requisite supply of blood for the maintenance of the ocular tissues."

† *Med. Chir. Trans.*, vol. lxiv. p. 1.

‡ *Ibid.*, vol. lxxxiii. p. 69.

Aneurism of the internal carotid is equally rare.

The following is a brief abstract of such a case (Dr. Wyeth, *Annals of Surgery*, August 1887, p. 114), in which the common and external carotids were tied, together with the superior thyroids, successfully.

The internal trunk was affected with atheroma to such an extent that the ligature could not be applied to this vessel. The operation was performed July 24, 1883. The tumour rapidly diminished in size, the patient leaving the hospital on the twenty-ninth day after the operation. She is now living and well.

6. In hæmorrhage caused by ulceration of the throat after scarlet fever.

This is a rare but most dangerous complication of ulceration of the throat, and is usually brought about either by sloughing of the soft parts, or, as in the case mentioned below, by the opening of an artery or vein into an abscess cavity.

My old friend Dr. Mahomed communicated a case to the Clinical Society (*Trans.*, vol. xvi. p. 21) in which this complication occurred in a patient aged 21. Secondary sore throat, after an ordinary convalescence, was noticed on the 54th day, with much swelling on the left side of the neck, followed by severe bleeding (to 40 ounces) from the mouth on the 58th day. The left common carotid was tied by Mr. Pepper on the 59th day. Five and a half ounces of pus were brought up soon after the operation, and the swelling of neck and pharynx subsided, a good recovery ultimately taking place.

The common carotid was selected for ligature in preference to the external, since it allowed the operation to be performed quite clear of the infiltrated tissues, and thus conferred a greater immunity from secondary hæmorrhage. Moreover, had the original bleeding come from the ascending pharyngeal, ligature of the external carotid might have failed to arrest it, as the place of origin of the former vessel is variable.

The next series of cases, 7 to 11, rather call for ligature of the external carotid than of the common trunk. With reference to them it must be remembered that ligature of the common carotid must be resorted to, not, as has too often been the case, on account of the greater facility with which this vessel can be tied, but only when the condition of the parts do not, either primarily, from an anatomical point of view, or, later on, after secondary hæmorrhage, admit of tying the external carotid itself.*

7. Incised or punctured wound near the angle of the jaw.

In these cases, as in those below, a correct diagnosis as to the vessel or vessels injured is by no means easy when a sharp weapon has passed obliquely and deeply behind the angle of the jaw. By such a wound either the external or the internal carotid or some branches of the former may be laid open. A careful dissection can alone clear up the source of the bleeding, and, whenever it is possible, this should be resorted to; where the circumstances do not admit of this, the surgeon, relying upon the extreme rarity of injury to the internal carotid from its protected position,† will be abundantly justified in tying the external carotid. Ligature of the common trunk is less reliable, though, if resorted to, on account of its simplicity, it may be defended by cases like those briefly alluded to by Mr. Le Gros Clark,‡ in which he successfully tied the common carotid for profuse arterial hæmorrhage due to stabs near the angle of the jaw. "The injury was inflicted in the same way, and with the same form of instrument, in both instances—a pointed table-knife was plunged downwards and inwards behind the angle of the jaw. The bleeding was, in each case, controlled only by direct pressure with the fingers in the wound; and whilst this pressure was maintained I tied the artery. Not an untoward symptom accompanied or followed either of these operations."

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* In some of these cases the hæmorrhage may be arrested, and the dangers of tying the common carotid avoided, by the temporary closure of this vessel by a loop of stout catgut, applied as at pp. 501, 509.

† Mr. Cripps (*Med. Chir. Trans.*, vol. lxi. p. 235) shows that, out of eighteen cases in which the bleeding vessel was identified, the internal carotid was found only to have been wounded twice alone, and once in conjunction with the external.

‡ *Lectures on Surgical Diagnosis, Shock, and Visceral Lesions*, p. 222.

On the other hand, cases of penetrating wounds near the angle of the jaw, ending fatally from hæmorrhage after ligature of the common carotid, will be found published by Mr. Travers (*Med. Chir. Trans.*, 1827, p. 165) and Mr. Partridge (*Lancet*, 1864, vol. i. p. 659).

8. Punctured wounds through the mouth.

Here, too, the common carotid has been tied in some cases successfully, while in others this step has been followed by repeated hæmorrhages and death.

The following case may be quoted as an instance of the former result:—A child fell while holding the sharp end of a parasol in his mouth, the point being thrust forcibly to the back of the fauces and very nearly coming through the skin at the side of the neck. Considerable hæmorrhage occurred at once, and also about a week later. Ten days later a gush of arterial blood followed on coughing. The common carotid artery was tied, and the case ended successfully.*

On the other hand, cases ending fatally after ligature of the common carotid for hæmorrhage after punctured wounds of the mouth will be found recorded by Mr. Vincent,† Mr. Arnott,‡ and Mr. Morrant Baker.§

9. Hæmorrhage from carcinoma of the mouth, *e.g.*, tongue or fauces.

This subject is discussed at p. 483. It would be better surgery to tie the lingual in the case of tongue cancer, or, if the growth be farther back, to tie the external carotid and ascending pharyngeal, and only, if this be found impossible, to ligature the common trunk.

10. Hæmorrhage after removal or incision of tonsils, or from an abscess about a tonsil.

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* The case was under the care of Mr. Johnson at St. George's Hospital. It is quoted by Mr. Durham, *Syst. of Surg.*, vol. i. p. 745.

† *Med. Chir. Trans.*, vol. xxix. p. 38. In this case the bifurcation of the right common carotid had been punctured by a bit of broken tobacco-pipe from within the mouth. Sloughy cellulitis set in, and hæmorrhage took place from the mouth a week after the accident. This was arrested by ligature of the common carotid, but recurred on the second, and again, fatally, on the fifth day after the operation. Mr. Vincent points out that if the bit of tobacco-pipe had been discovered and removed, fatal hæmorrhage must have followed instantly, as the artery was not only wounded, but plugged by the foreign body.

‡ *Lancet*, 1864, vol. i. p. 135.

§ *St. Bart. Hosp. Reports*, 1876, p. 163.

These cases are infrequent, but, when they do occur, are, in many cases, most dangerous. The sources of the hæmorrhage are very numerous—viz., (1) One of the tonsillar arteries. (2) The tonsillar venous plexus. (3) The ascending pharyngeal. (4) The internal carotid. Hæmorrhage from the last two is much more likely to occur in suppuration in or around the tonsil than in wounds inflicted during operations on it.

The following is a good instance (Mr. Pitts, *St. Thomas's Hosp. Reports*, vol. xii. p. 131) of a tonsillar abscess proving fatal from hæmorrhage. A man, aged thirty-nine, was admitted with severe tonsillar abscess, which soon burst with the escape of a little blood. About 16 oz. were lost on the third day, bleeding again recurring on the fourth and fifth. The left common carotid was now tied; thirty hours afterwards 22 oz. were lost, and the patient died.

There was an abscess cavity around the left tonsil which communicated with the left internal carotid by an opening the size of the little finger nail.

Mr. Morrant Baker has recorded a case of suppuration around the tonsil dating to an injury. Here the vessel injured was the ascending pharyngeal, but too short a time elapsed between the ligature of the common carotid and the death of the patient to say whether the operation would have been successful.

A man, aged twenty-three, was admitted with symptoms of acute tonsillitis, the parts being tense, elastic, and prominent at one spot. A puncture was only followed by the escape of blood. The patient now gave a history of having fallen two days before, when drunk, and having grazed his throat with a clay pipe; this had been followed by very little bleeding. The temperature went up to 105°, and arterial hæmorrhage occurred on the third day after admission. A probe passed through the puncture showed that a considerable cavity existed; this was plugged with lint soaked in tr. ferri perchlor. The next day hæmorrhage recurred to half a pint; when ether was given, the bleeding again came on, nearly suffocating the patient. On exploring the cavity with a finger-tip, a bit of clay pipe was withdrawn; the cavity was again plugged and the common carotid tied. The patient died, without rallying, three hours later. A wound was found in the ascending pharyngeal artery.

Given a case of hæmorrhage from the tonsil (whether from a wound or an abscess) which resists other treatment, including well-applied pressure kept up with a padded stick inside the mouth and a finger behind the angle of the jaw, the surgeon should tie the external carotid as low down as possible, placing a ligature on the ascending pharyngeal as well, if this vessel can be identified. If the bleeding is from one of the tonsillar vessels it would be thus arrested, but in case the ascending pharyngeal is not secured, or the bleeding comes from the internal carotid, a loop of stout chromic gut should be placed as well under the top of the common carotid in the manner recommended by Mr. Rivington and Mr. Treves (pp. 501, 509).*

11. Hæmorrhage after operations on the neck or jaw. Hæmorrhage secondary to gunshot injuries.

In both these cases the parts may be so altered that it is quite impossible to find the bleeding point, and the soft parts may be so damaged, matted together, &c., that the surgeon may be driven to tie the common carotid, and trust to this and to plugging the wound, rendered as aseptic as possible, with sal alembroth or iodoform gauze,† and sponge-pressure over all.

12. To arrest the growth of aneurism by anastomosis on the side of face, head, and neck.

The treatment of this condition is discussed at p. 509. It will be shown there that ligature of the external carotid cannot usually be looked upon as sufficient without other measures, owing to the free anastomosis between the branches of the opposite vessels. Still less is ligature of the common carotid likely to be successful, and this step should only be resorted to when ligature of the external carotid is impossible from the disease extending too low down, when, from its creeping towards the orbit or at the back of the upper jaw, it is probable that there is a free anastomosis between the branches of the external and internal carotid through the ophthalmic, or when the ascending pharyngeal is sure to be involved, but this branch cannot be separately ligatured.

13. To arrest the growth of malignant tumours of the jaws which cannot be operated on, or which are recurrent.

This operation, first performed by Mott, is a very proper one in cases of malignant disease of the antrum, nose, &c., where the growth cannot otherwise be attacked and is growing very rapidly, causing frequent bleeding, intense pain, and threatening to interfere with deglutition and respiration. The surgeon must be prepared for a good deal of sloughing, fœtor, &c., as well as shrinking in very vascular growths which have begun to fungate. In this case, also, it will be a question as to whether it is wiser to ligature both external carotids or the common carotid. The cases given at p. 512 may help here. If the common carotid is tied, the opposite external carotid should be ligatured also, either at the same time or very shortly after, owing to the free anastomoses, which will bring blood over from the opposite side. In any case it should be an operation to be performed at the patient's request after the matter has been explained to him, in the hope that its performance may lead to relief from the urgent local symptoms of the growth, and that life may be brought to a close, after an interval of relief, by increasing, but less painful, asthenia.

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* Every care should be taken throughout to keep the wound in the tonsil as aseptic as possible. As bearing on the use of iron perchloride as a styptic, see some remarks at p. 481.

† These may first be soaked in turpentine (p. 481).

LINE.—From the sterno-clavicular articulation to a point midway between the angle of the jaw and the mastoid process.

GUIDE.—The above line, and the inner edge of the sterno-mastoid.

RELATIONS.—The common carotids, as far as their relations in the neck go, extend from the sterno-clavicular articulation to the upper border of the thyroid cartilage, along a line from the above joint to a point midway between the jaw and the mastoid process.

IN FRONT.

Skin; fasciæ; platysma; superficial branches of transverse cervical, and anterior jugular.
Sterno-mastoid, sterno-hyoid, sterno-thyroid, omo-hyoid, sterno-mastoid artery.
Superior and middle thyroid veins.
Descendens noni.
Anterior jugular vein (below).

OUTSIDE.	INSIDE.
Internal jugular (closer on left side).	Pharynx.
	Larynx.
	Trachea.
	Thyroid gland and vessels.
	Recurrent laryngeal.

Common carotid.

BEHIND.

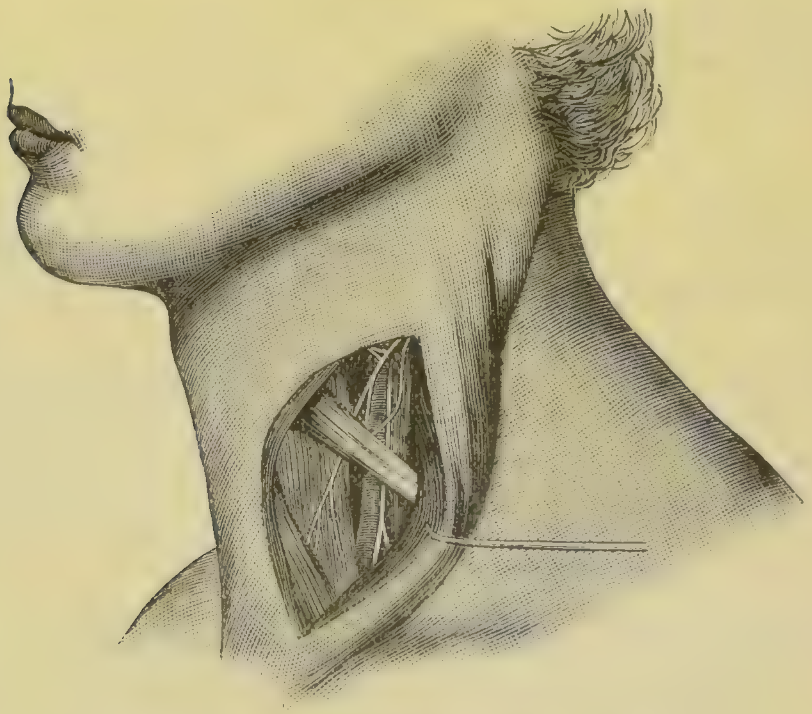
Rectus capitis anticus major.
Longus colli.
Sympathetic.
Inferior thyroid artery and recurrent laryngeal.
Vagus.

Operation.—Two sites are usually described, according as the vessel is tied above or below the omo-hyoid.

A. ABOVE THE OMO-HYOID (Figs. 99, 100).—Also known as the seat of election, owing to the greater facility with which this operation is usually performed.

The parts being cleansed and shaved if needful, the shoulders are sufficiently raised, and the chin at first drawn a little upwards, while the head is turned to the opposite side,* so as to define the anterior border of the sterno-mastoid.† The surgeon, standing usually on the same side, makes an incision about 3 inches long, with its centre opposite to the cricoid cartilage, in the line of the artery, through the skin, platysma, and fasciæ, exposing the anterior border of the sterno-mastoid. Any superficial veins are now drawn aside, or tied before division with double catgut liga-

FIG. 99.



Surgical anatomy of common carotid. (Maunder.)

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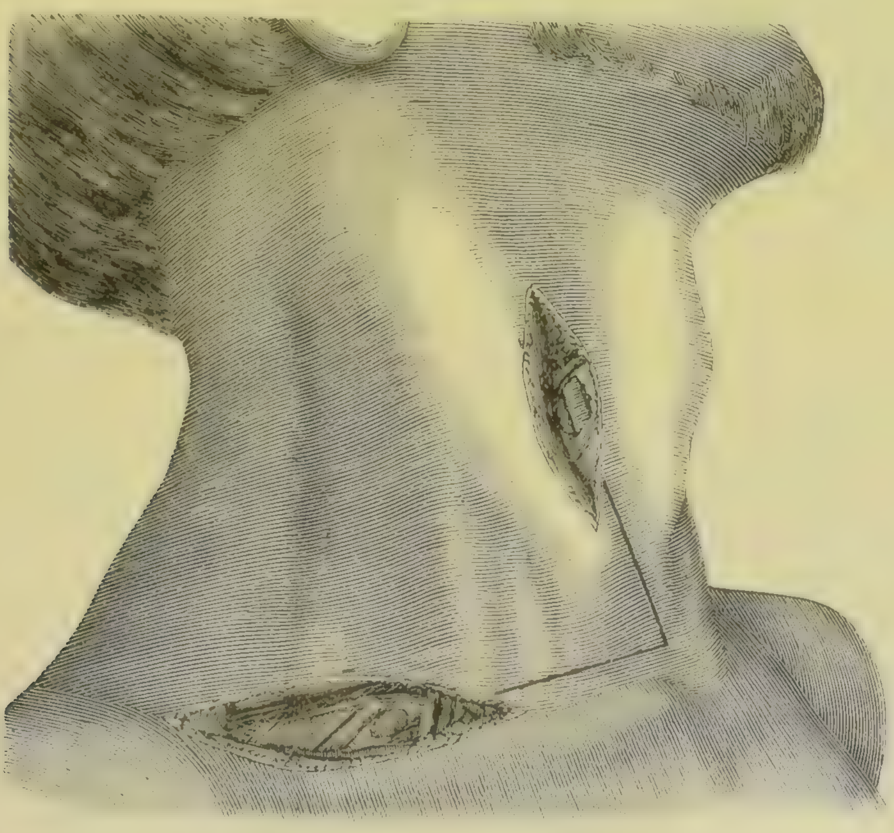
[*] Turning the head strongly to the opposite side should be avoided, as it brings the muscle over the artery. Mr. Barwell (*Encycl. Surg.*, vol. iii. p. 498) gives the following practical hint:—"In certain aneurismal cases (aortic and innominate) the etherized patient cannot breathe while his head is thrown back; the anæsthetizer is obliged to insist on bending it forward, and the operator has to get at the vessel under very trying circumstances, since in that posture it lies much deeper, and the ramus of the jaw is terribly in the way."

[†] Not always easy on the dead subject, or when the parts are infiltrated, as in Mr. Vincent's case (foot-note, p. 494), or in Mr. Rivington's (p. 489).

tures. The deep fascia at the anterior border of the sterno-mastoid is now divided, and the cellular tissue beneath opened up, usually bringing into view the upper border of the omo-hyoid, which, if in the way, is drawn down with a blunt hook, or divided. The edge of the sterno-mastoid is now drawn outwards, and the pulsations of the artery felt for just below the omo-hyoid.* In clearing the tissues which remain over the vessel, troublesome hæmorrhage may arise from the superior and middle thyroid veins, especially if the respiration is embarrassed; more rarely the sterno-mastoid artery is cut, and requires a ligature. The sheath is next exposed, and opened well to the inner side, avoid-

FIG. 100.



In the ligature of the common carotid the only structures seen are the omo-hyoid, crossing the vessel below, and the superior thyroid vein above. Externally is a portion of the internal jugular, and more superficially the sterno-mastoid. The deep fascia is seen in the upper and lower angles of the wound.

In the ligature of the subclavian, the sterno-mastoid and the trapezius are seen in the angles of the wound. Above the vessel lie the cords of the plexus, crossed by two veins, probably the transverse cervical and the posterior scapular, coursing inwards to join the external jugular, which is seen at the inner part of the wound. Below the subclavian artery is seen a portion (too much is shown) of the supra-scapular artery.

The angular incision shows that for ligature of the innominate, the first part of the subclavian, and, in cases of difficulty, the first part of the carotid.

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* This muscle should be drawn downwards, or divided if needful.

ing the descendens noni, which usually lies to the front and outer side of the sheath.*

Other difficulties which may be now met with are an enlarged thyroid lobe overhanging the artery, or overlapping of it by the internal jugular when much distended. The coats of this vessel are so thin that, if it be much swollen, it is easily punctured, the result being that the wound is flooded with blood. It is best avoided by opening the sheath well to the inner side, but, if it still give trouble, it should be drawn aside with a blunt hook, or pressure should be made on it by an assistant in the upper angle of the wound. If it should be opened, firm pressure should be made on this spot with a sponge-holder, and the artery tied at a fresh place above or below. As soon as the ligature is tightened the hæmorrhage will cease, and firmly applied pressure outside the wound for forty-eight hours will suffice to prevent any recurrence. If, after wounding the vein, attempts are continued to tie the artery at the same place, the wound in the vein is almost certain to be made larger. Other methods are to pinch up the wound in the vein and tie up the opening (if small) with fine carbolized silk or chromic catgut, or to leave on compression-forceps.

The sheath having been opened well to the inner side with a careful nick of the knife, the artery is now cautiously and sufficiently cleaned, the inner edge of the sheath being held with forceps while this side of the vessel is cleaned, and then the outer in the same way, and, finally, the posterior aspect, the point of the director being kept most scrupulously in contact with the vessel here.† The needle is then passed from without inwards, being kept most carefully close to the artery, especially behind, so as to avoid including the vagus.

In this as in every other artery whose relations are important, the fewer of these relations that the surgeon sees the more masterly and successful will his operation be.

In a deeply lying artery, in addition to relaxing the parts by flexing forward the head and depressing the chin, the sterno-mastoid must be drawn outwards and the larynx inwards with retractors, while the omo-hyoid is drawn downwards with a blunt hook, or divided. The pulsation of the artery is then felt for, or where this is feeble or absent, the rolling of the artery as a flat cord under the finger is made out.

B. LIGATURE BELOW THE OMO-HYOID.—Here the artery lies much deeper, and has the recurrent laryngeal nerve behind it: on the left side, the internal jugular vein lies very close to the artery; on the right, there is a distinct interval between the two vessels.

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* The position of this nerve is, however, very irregular.

† Opening the sheath on the inner side and cleaning the vessel properly ar the two best safeguards against accidents.

The patient's head and the operator being in the same position as at p. 598, an incision 3 inches long is made in the line of the artery from below the cricoid cartilage to just above the sterno-clavicular joint, exposing, as before, the anterior edge of the sterno-mastoid. This is drawn outwards, and, if needful, divided or detached below by making a short incision outwards along the clavicle. In this case the anterior jugular vein must be carefully looked for as it passes outwards in the root of the neck under the sterno-mastoid. The depressors of the hyoid bone next come into view; of these the sterno-hyoid, overlying the broader sterno-thyroid, is certain to be seen. If the omo-hyoid is coming up at this level, it lies external to the others. In such case it is to be drawn out while the other two are pulled inwards, any of the three being divided, on a director, if needful. At this stage one or more of the inferior thyroid veins may come into view, much swollen. The pulsation of the artery being felt for, or the flattened artery felt slipping beneath the finger when pressed upon, the sheath is to be opened well to the inner side, retractors usually being required at this stage. Care must be taken of the internal jugular, especially on the left side, as, if distended, it may conceal the artery (p. 500).

When the carotid is sufficiently cleaned, the needle is passed from without inwards, avoiding the recurrent laryngeal nerve behind by keeping very close to the artery.

Temporary Ligature of the Carotid.—Mr. Rivington (p. 508) and Mr. Treves (*Lancet*, January 21, 1888, p. 111) have drawn attention to this method, believing that the ligature of main arteries is resorted to too often, as there is sufficient evidence to show that in most cases it is only temporary arrest of the current that is required.

This method should certainly receive a further trial, on account of the risks of cerebral mischief after ligature of the carotid, and also because, as Mr. Treves says, pressure upon the carotid cannot be successfully maintained for a serviceable length of time.

The artery being exposed in the ordinary way, a thick piece of soft catgut is passed round it and tied in a very loose loop. By pulling on the loop, the blood-current is at once arrested, and restored when the tension is relaxed.

The following are abstracts of the four cases given by Mr. Treves:—

1. Probable Wound of Superior Thyroid Artery.—A young man was admitted with a deep, profusely bleeding wound about the level of the great cornu of the hyoid. A fragment of glass driven in by a bursting soda-water bottle had been removed. The patient was blanched and almost insensible. It being "obviously useless to attempt to find the bleeding point while blood was welling up from so deep a wound," Mr. Treves placed a temporary ligature round the common carotid. Traction on this arrested all bleeding, and was maintained for half an hour. On relaxing the catgut, no hæmorrhage occurred. The loop was left *in situ* for four days, and then removed. The bleeding was supposed to come from the superior thyroid.

2. Hæmorrhage from Internal Carotid.—A child, aged three, had profuse hæmorrhage from the right ear, and vomited blood. This recurred, and the right common carotid was ligatured, and the bleeding ceased. The next day the same hæmorrhage recurred, having evidently been brought round by the left carotid. As there is no case on record of recovery after ligature of both common carotids when the interval between the occlusion of the two vessels was less than some weeks, Mr. Treves simply placed a loop of catgut round the left carotid, and had traction made on it. The child never bled again, but sank exhausted six days after the second operation.

3. Hæmorrhage probably from External Carotid, after Impalement with a Spike.—A man, aged forty-one, fell 26 feet upon a railing spike, which, entering just in front of the left ear, passed through the upper jaws, and entered the mouth through the hard palate on the right side. After removal of the spike, blood welled up freely from the wounds and nose. Traction made on a catgut loop passed round the common carotid arrested this. A weak pulse could be felt in the temporal on the fourth day, and on the seventh the loop was removed. The case did well. It is not stated how long traction was maintained.

4. Hæmorrhage during an Operation.—In this case the loop was placed around the artery prior to removing a large malignant tumour of the neck. Very free bleeding occurred during the operation, but was always checked by traction on the loop. Without this the operation would have been very difficult.

Old Operation for Ligature of the Common Carotid.—This, perhaps the most formidable operation in surgery, was successfully made use of by Prof. Syme (*Observ. in Clin. Surg.*, p. 154) in a case of aneurism the result of a stab. The aneurism, about the size of an orange, extended between the trachea and sterno-mastoid, and downwards close to, or rather under, the clavicle. Nearly at its centre was a cicatrix. It was increasing in size, and, other treatment having failed, it was decided to perform the old operation, it being evidently impossible to apply a ligature below the aneurism.

"I pushed a knife through the cicatrix, and followed the blade with the forefinger of my left hand so closely as to prevent any effusion of blood. I then searched through the clots and fluid contents of the sac for the wound of the artery, and found that pressure at one part made the pulsation cease. Keeping my finger steadily applied to this point, I laid the cavity freely open both upwards and downwards, turned out the clots, and sponged away the blood so as to get a view of the bottom, which presented the smooth, shining aspect of a serous membrane, without the slightest indication of either the artery or vein that could be seen or felt. In order to make the requisite dissection, I next attempted to close the orifice by means of forceps, but found that it had the form of a slit, which could not be thus commanded. It was also so near the clavicle that pressure could not be employed below it, and, to my still greater concern, lay on the inner or tracheal side of the vessel, so that the compression required for its closure, instead of being backwards on the vertebræ, was outwards upon the vein. In these circumstances it seemed proper, so far as possible, to lessen the opposing difficulties, and I therefore ran a bistoury through the skin and the sternal portion of the sterno-mastoid. I then seized the edge of the slit in the artery, as it lay under my finger, with catch-forceps, and desired them to be held so as to draw the vessel towards the trachea; I then carefully scratched with the point of a knife until the arterial coat was brought into view at its external edge, a little above the aperture, where a ligature was passed by the needle, and tied. I repeated the same procedure below the wound, and, when it was completed, had the satisfaction of finding that my finger could be withdrawn without the slightest appearance of bleeding, instead of the tremendous gush which had previously attended its slightest displacement. The ligatures separated on the tenth day, and the patient recovered completely."

Prof. Syme considered this by far the most arduous operation he had undertaken, from the fact that "the slightest displacement of one hand must have instantaneously caused a fatal hæmorrhage from the carotid artery, and a wrong direction of the needle by the other, to the smallest possible extent, would have given issue to an irrepressible stream from the jugular vein."

Mr. Erichsen* gives the following graphic picture of the difficulties of the operation :—" The hæmorrhage having been completely arrested, either by compression of the artery above the tumour, or by pressure of the fingers at the opening leading into the tumour,† you lay it open freely and completely, turn out the coagula, and syringe away any dark or fluid blood which may be there. You then open the interior of the aneurism. But what is that interior? It is not the interior of a smooth sac, but it is a large ragged cavity with masses of coagulum or solid fibrin sticking to it in different directions, with the remains, perhaps, of an old sacculated aneurism at the bottom, with a quantity of plastic matter infiltrating the tissues around it, with the anatomical relations of the parts utterly and completely disturbed and destroyed, with great thickening and solidification of the parts around from the pressure to which they have been subjected in consequence of the effusion of plastic matter. So you have a large cavity with an opening at the bottom of it, the opening leading to the artery somewhere or other, but the position of the artery more or less disturbed, more or less masked and obscured by these masses of coagulum, by this plastic infiltration, by this thickening and cohesion of the tissues to one another around it. The next thing is to pass the ligature around the artery. Now, the artery does not lie exposed in this sac; quite the contrary. You have to scrape, or to dissect, or cut through the posterior wall of this sac, which always overlies the artery. That constitutes the great difficulty of the operation—to open up this posterior wall in a proper direction, and to get the needle round the part without wounding the contiguous vein, or transfixing the artery, or doing damage to the neighbouring parts. The best way of doing that, undoubtedly, is to introduce a large steel probe or a metallic bougie into the opening into the artery, and to use that as a guide to the situation of the vessel. You may use a large one so as to plug up the opening.‡ . . . . You then clear the vessel as well as you can—the coats are generally thickened and diseased in the vicinity of the aneurismal tumour—and you pass a good double ligature around it."

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* *Lancet*, 1868, vol. ii. p. 505.

† Mr. Erichsen thus puts Prof. Syme's practical point—" to make a small opening into the tumour, an opening just sufficient to enable you to insinuate your fingers, and so to work your whole hand gradually into the tumour in that way, so that the entrance of the hand may plug up the opening into the sac; to feel with your fingers for the opening into the artery, and to get your fingers against that, so as to restrain the flow of blood from it, before the rest of the sac is laid open."

‡ In one case, as stated by Mr. Erichsen, Mr. Birkett used a large bougie as a guide.

Difficulties and Possible Mistakes during Ligature of the Common Carotid.

1. Altered condition of the soft parts—*e.g.*, matted and œdematous from the close contiguity of an aneurism, from a previous trial of pressure; or loaded with blood or inflammatory products, as in the case of a wound.

2. Presence of an aneurism encroaching upon the incision.

3. Not hitting the edge of the sterno-mastoid. This muscle may be drawn over the artery if the chin be too much forced to the opposite side. The chin should be kept about midway between the acromion and the episternal notch of the opposite side (Barwell).

4. Great enlargement of the superior and middle thyroid veins.*

5. An enlarged and overlapping thyroid gland.

6. A large internal jugular overlapping the artery.

7. Opening the sheath towards its outer side, and so coming down upon, and perhaps injuring, the vein.†

8. Including one of the nerves‡ in relation with the artery—*e.g.*, the descendens noni, the vagus, or the sympathetic (p. 489).

Causes of Failure and Death after Ligature of the Common Carotid.

1. Cerebral complications—*e.g.*, impaired nutrition and softening. Mr. Erichsen thinks that "cerebral symptoms" (he does not say whether he means fatal ones or no) are liable to occur in

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* Mr. Barwell (*Intern. Encycl. Surg.*, vol. iii. p. 499) says that the superior thyroid vein, very full and turgid, sometimes runs before, more often behind, the carotid. "I suppose it is the effect of the anæsthetic which causes this to swell to the size of a cedar pencil."

† On the dead body, especially, there is a risk of mistaking the flaccid jugular for fascia, and opening it, unless the sheath has been opened over its front and inner part, as should be always the practice.

‡ "The descendens noni lies usually on the outer part of the sheath, and will rarely be endangered if that structure is opened as above described; but it is well to see that it is out of the line taken by the director; if its absence there be verified, it need not be hunted up elsewhere. The pneumogastric lies in the interval between the artery and vein in the back part of, but not loose in, the sheath; each of the vessels, as well as the nerve, has a compartment, strongly walled, to itself; while the sympathetic, behind the sheath, is also separated by a thick fascia from the vessels. If these anatomical positions be maintained, both nerves are safe. Young operators are sometimes made anxious and embarrassed by unnecessary cautions, yet sometimes the parts do not quite maintain their proper positions. Hence it is well, before tightening the ligature, to see that it includes the artery only."—BARWELL (*loc. supra cit.*).

25 per cent. of ligatures of the common carotid. They may come on almost at once, or some days after the operation. Mr. Erichsen divides them into two sets—(1) the early ones, resulting from the too small supply of arterial blood, viz., syncope, twitchings, giddiness, impaired sight, and hemiplegia; (2) after the above have been present for a few days, and softening has taken place, convulsions and death ensue.*

It would be, perhaps, worth while, in view of the above mortality, to try pressure before resorting to the ligature, in order that the opposite vessels may become enlarged. Pressure could only be kept up, without an anæsthetic, for a few minutes at a time, and care would have to be taken not to apply it at the intended site of ligature. The temporary ligature (p. 501) also deserves trial.

2. Cellulitis and septic complications.

3. Recurrent pulsation. In most cases this is due to blood finding its way round from the opposite side. The pressure, however, in cases of aneurism, having been relieved, coagulation, as a rule, takes place, though slowly.

In a smaller number of cases the recurrence of the pulsation has been of a more permanent kind, from the ligature becoming loosened or dissolved, especially when catgut has been used.

4. Suppuration of the sac. Mr. Erichsen states that this is not very uncommon. "In the majority of cases the patient eventually does well."

5. Hæmorrhage. This has never been a common complication, owing to the absence of branches. It may take place from the site of ligature† or from a suppurating sac. It should be still more rarely met with in the future, owing to the modern treatment of wounds.

6. Low forms of lung-inflammation. Mr. Erichsen states that these are not uncommon. He attributes them to diminished freedom of the respiratory movements owing to the disturbed circulation in the brain and medulla.

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* Mr. Barwell (*loc. supra cit.*) argues, from the fact that in no case of ligature of the innominate—an operation which cuts off all the right blood-supply—have cerebral symptoms supervened, that there must be some other cause than brain anæmia for these complications: he thinks that a large majority of the cases in which so-called cerebral symptoms supervened from the seventh to the tenth day were cases of pyæmia, and that in some cases detachment of minute portions of clot may have been the cause.

† This danger would seem to increase the lower down the ligature is placed. Mr. Barwell says that the only fatal case of secondary hæmorrhage he has had in this operation followed the ligature of a carotid with catgut close above the sterno-clavicular joint. It is not stated whether the wound was aseptic throughout or not.

LIGATURE OF THE EXTERNAL CAROTID (Fig. 102).

This operation has not received the attention which it deserves, having been too often set aside for the easier operation of ligature of the common trunk.

Mr. Cripps,* discussing the ligature of the external carotid in the treatment of hæmorrhage from punctured wounds of the throat and neck, states that the objections raised to the above operation are—

1. The fear of secondary hæmorrhage from the seat of ligature due to the close proximity of its larger branches.

In answer to this he refers to M. Guyon's† collection of 27 cases of ligature of the external carotid, to which he adds 3. In only one case of these 30 did secondary hæmorrhage occur. Larger statistics than these have been furnished by Dr. Wyeth, of New York. He states that, of 67 cases in which the external carotid alone was tied, 3 died, and that all these fatal cases were from gunshot injuries in military practice. One of these fatal cases died on the table from the effects of hæmorrhage before the ligature could be applied. In the other 2 the cause of death is not given. Of the 67 cases, hæmorrhage occurred after ligature in 5, none of which proved fatal. In 4 of these the bleeding was noted as occurring at the seat of lesion beyond the ligature. The artery was tied on both sides in 2 patients, and both recovered.

Dr. Bryant, of New York,‡ states that he can add 16 cases to the above 67, and that in only one of these did the subsequent death bear the least relation to the operation itself.

2. The futility of the operation, should the wounded vessel be the internal carotid.

Mr. Cripps answers this objection by comparing the rareness of a wound of the internal carotid with one of the external or its branches. He points out that, of eighteen cases in which the bleeding vessel was identified, the internal one was wounded twice alone, and once in conjunction with the external.§

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* *Med. Chir. Trans.*, vol. lxi. p. 234.

† *Mém. de la Soc. de Chir.*, vol. vi. According to Prof. Agnew (*Prin. and Pract. of Surg.*, vol. i. p. 636), out of nineteen cases of ligature of the external carotid only one proved fatal from hæmorrhage, and none from causes which could properly be attributed to the operation.

‡ *Ann. of Surg.*, August 1887, p. 122. In this fatal case both external carotids had been tied to check the rate of progress of malignant disease of the lower jaw, floor of mouth, and tongue, which had been operated on repeatedly without success.

§ Mr. Cripps' list is interesting to the surgeon. In the first 10 it is to be pre-

3. The external carotid is less easy to ligature than the common.

This objection will not weigh with a surgeon who knows his anatomy, and who is in the habit of operating.

The advantages of the operation are—

1. That the circulation through the brain is not in the least interfered with. Consequently, one large element of danger is avoided (p. 505).

2. The incision made over the external carotid can also expose the bifurcation and the internal carotid, and may thus lead to a direct exposure of the wounded vessel.

Indications.

i. Wounds of the Trunk and of its Branches.—This subject has been already alluded to (p. 493). While it cannot be denied that the easier operation of ligature of the common trunk has answered in some of these cases, it has also certainly failed repeatedly. Considering the rarity of wounds of the internal carotid, the surgeon will do more wisely, in the case of a wound over the carotid area, to expose and tie the external carotid low down in any cases of doubt, that the trunk and the internal carotid may be exposed as well, if needful.

Mr. Rivington has recorded (*Clin. Soc. Trans.*, vol. xvii. p. 79) an interesting case of a wound of the external carotid by a stab in the parotid region giving rise to recurrent attacks of hæmorrhage, and treated successfully by temporary* ligature of the common carotid and ligature of the external carotid at the seat of injury.

A man, aged thirty-one, was admitted into the London Hospital with three wounds, one severing the lobule of the left ear and passing into the parotid gland below the zygoma, a second behind the ear, and a third over the mastoid process. Hæmorrhage, occurring about a week later, was stopped by pressure. Erysipelas followed, and an abscess was opened in front of the ear. About three weeks after the accident, hæmorrhage again occurred, being brought on by a fit of coughing, blood running out from all the

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sumed that ligature of the external carotid would have been the wiser course. In 2 the bleeding came from the external carotid; in 1, the lingual; in 1, the facial; in 1, a tonsillar branch; in 1, a branch in the parotid gland; in 2, the internal maxillary; in 1, the inferior dental; in 1, the middle meningeal; in 1, the vertebral; in 2, the internal carotid; in 1, the external also was wounded; in 1 the source was close to the bifurcation; in 2 the common carotid, at the point of bifurcation, was wounded; in 1, the ascending pharyngeal.

* Some cases in which Mr. Treves has more recently made use of this step are given at p. 502.

incisions. Though it was again arrested by pressure, Mr. Rivington judged, from the size of the stream and the force of the jet, that the injured vessel must have been the external carotid in the parotid gland.

On account of the difficulty of securing the artery at the seat of injury, and the amount of blood which would be lost before this could be accomplished, and not being able to rely upon pressure on the common carotid during the operation, Mr. Rivington cut down first on the common trunk at its bifurcation and placed a temporary ligature of catgut round it,* tying this lightly so as to stop the current of blood, but not to divide the inner and middle coats.

The openings in the parotid region being explored and clots turned out, a little below the angle of the jaw was found a hole from which some blood issued in a feeble stream. The external carotid was ligatured above and below this spot. The ligature in the main trunk was then untied, and left *in situ* for use if needed. All bleeding had ceased, and there was no recurrence. The patient made a good recovery, some weakness of the face muscles having almost disappeared when he left the hospital.

Mr. Rivington draws attention to the advantage of the temporary ligature on the main trunk, rendered very evident by the fact that immediately before the operation, when the sponge was removed, arterial blood spurted out in a lively jet, whilst after the ligature a languid stream only issued, from the distal side of the hole in the external carotid. He further points out that the employment of temporary ligatures, either lightly tied or left *in situ* for use in case of need, is capable of wider application in the treatment both of hæmorrhage and of aneurisms.

ii. Aneurism by Anastomosis of Scalp and Side of Head and Neck (Fig. 101).—Here the ligature of the external carotid should only be made use of as an adjunct to local treatment, or where this has failed.

If the growth is not too large, it should be excised with antiseptic precautions, tying each vessel as it is cut. The operation may be rendered partly, if not entirely, evascular by the use of stout india-rubber bands passed round the back of the head and the lower jaw, with pledgets of lint over the main vessels—*e.g.*, temporal or external carotid, posterior auricular, and occipital. Another method is one made use of by Mr. Hutchinson in the removal of an enormous fibro-cellular tumour of the scalp—viz., a Petit's tourniquet passed around the back and sides of the head and lower jaw (p. 151).

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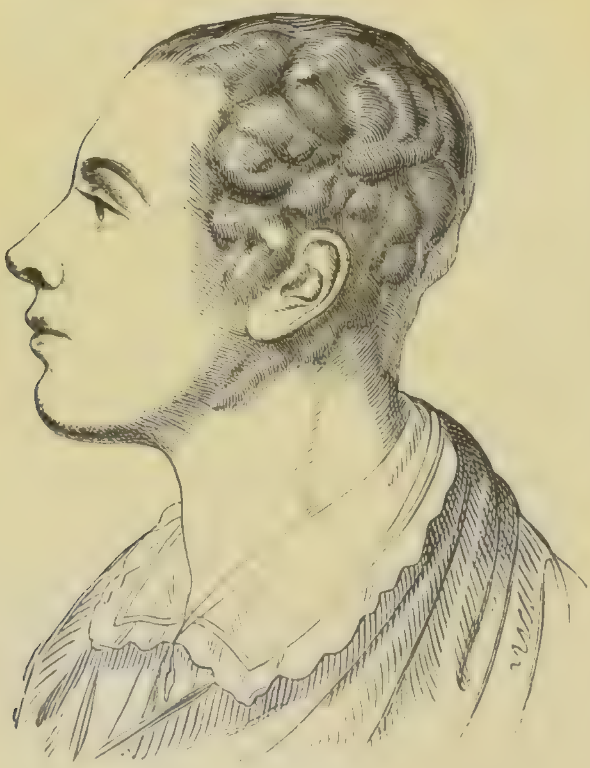
* It remained uncertain whether this temporary ligature was placed on the external or the common carotid.

If the above are not applicable, the external carotid may be tied preliminary to removing the tumour. When this is being effected, any skin that is not too much involved should be preserved. If this is impossible, the growth must be taken away, with the skin over it, the vessels being secured as cut. Every pains must be taken to keep the wound aseptic, and thus promote rapid granulation-healing, completed by skin-grafting.

If excision is not feasible, the main vessels of supply should be under-run with pins, in order to bring about their closure and, ultimately, the obliteration of the growth.

The case from which Fig. 101 is taken was that of a woman, aged twenty-two, who was thus treated by Sir W. Fergusson (*Pract. Surg.*, 4th edit. p. 162, fig. 73). The common carotid had been previously tied by Mr. Storks, but the vessels slowly increased in size. Long needles were passed under and through the vessels at the most prominent points, being sufficiently strong to bear the pressure, made by twisting strong threads about them over the included vessels and scalp. At some points sloughing occurred; elsewhere ulceration loosened the needles. In about three weeks, as anticipated, hæmorrhage took place. Digital pressure was made use of till fresh needles were introduced and the old ones withdrawn, when threads were again applied, and the bleeding arrested. Further inflammation and obliteration of the vessels ensued, repeated hæmorrhages were arrested in a similar manner, the formidable affection being ultimately completely obliterated.

FIG. 101.



(Fergusson.)

In a similar case it would probably be wiser to tie the external carotid before inserting the pins.

The following case, published by Mr. Wood (*Lancet*, 1881, vol. ii. p. 255), is an excellent instance of the same treatment, aided by the antiseptic advantages of the present day:—

A man, aged thirty-seven, had a pulsating tumour in the right parietal region, of the size of a hen's egg, with a bruit, together with a pulsating swelling running forwards to the left orbit, the eyeball being pushed forwards, while a loose, pulpy, nævoid condition extended into the occipital region. With antiseptic precautions, stout steel pins were run under the right supra-orbital, temporal, and occipital arteries. The left occipital and temporal had to be occluded before the pulsation stopped, and four pins were also passed under the swelling itself and in its neighbourhood. The pins were passed quite down to the bone, and were made to emerge clear beyond the vessels. These were compressed with silk over thick india-rubber pads, which served to tighten up the pressure as the pins cut through. About an hour after the operation intense neuralgic pain in the occipital region was experienced from inclusion of the nerve. The antiseptic precautions were stopped in ten weeks, and the patient was quite cured without any bleeding, suppuration, or sloughing, save, to a very limited extent, at one spot.

As these cases are most obstinate, my readers will excuse me if I draw their attention to another case proving that ligature of the external carotid (even if performed on both sides) is not likely to be successful without local treatment as well—viz., either under-running the vessels with pins, or excision. It is recorded by Dr. Bryant, of New York (*Annals of Surgery*, August 1887, p. 116). The patient, aged twenty-four, had a well-defined pulsating tumour at the site of a healed scalp-wound in front of the left ear. The trunk and branches of the temporal and the occipital were concerned in the growth. As this was rapidly increasing, the left external carotid was tied with catgut about half an inch above its origin. Tying the lingual artery also provided a branchless portion of the external carotid about an inch in extent. The ascending pharyngeal was sought for, but not found. All pulsation was at once checked, and the growth was also reduced to about one-third of its previous size. The operation was antiseptic throughout, and when the dressings were changed for the first time in ten days, a slight return of pulsation was noticed in the tumour. A month after the operation, pulsation, thrill, and bruit were nearly as strong as before, and it was decided to attack the tumour itself in preference to tying the occipital and temporal branches, or the right external carotid. The arterial circulation was admirably controlled by surrounding the head with two strong rubber bands, beneath which compresses were placed at the points where arteries passed to supply the scalp. Dr. Bryant has found eight other cases of ligature of the external carotid for the cure of aneurismal tumours of the head, face, and parotid gland, in two of which both the vessels were tied simultaneously. This latter procedure is not reported to have been successful in either case. Of a total of nine cases, only one, a traumatic aneurism of the parotid, was cured by ligature alone.

Thus it would appear that local remedies—viz., excision and under-running, aided by ligature of the chief feeding arteries—are most likely to be successful in this disease, which so often baffles treatment. Ligature of the external carotid, on one or both sides, will fail, owing to the free collateral circulation, if tried by itself even in recent traumatic cases without much general dilatation of the vessels. If used at all, it should be so as an adjunct and a preliminary step to diminish the vascularity of the tumour before this is dealt with locally by the methods above indicated.

iii. Aneurism of the External Carotid.—The treatment of this rare condition has been already discussed at p. 491.

iv. As a Preparatory Step to extirpating Malignant Tumours of the Upper Jaw, Pharynx, &c., or as a Palliative Step where the above Extirpation cannot be attempted.—This question has already been discussed at p. 496. The following cases (Dr. Bryant, *Ann. of Surg.*, August 1887, p. 121) are of interest as bearing on this matter. In each of these cases repeated operations had been performed for removal of malignant disease involving the lower jaw, floor of the mouth, and more or less of the tongue. Rapid recurrence had taken place in each case, until, the use of the knife no longer appearing feasible, the only course seemed to be starvation of the growth. Accordingly, this was attempted by simultaneous ligature of both the external carotids, by incisions in the usual place, the enlarged lymphatic glands found being removed. When the carotids were reached, most unusual anomalies were found. The right common carotid bifurcated beneath the posterior belly of the digastric, which was divided to admit of passing the ligature. On the left the bifurcation was behind the hypo-glossal nerve, which was drawn down, and the ligature then passed just below the digastric. The lingual and facial branches were not seen on the right side, but this caused no apprehension, as the facial was said to have been tied some months before, during removal of the diseased sub-maxillary gland on that side. On the left side the branches of the external carotid were normal. The operations were antiseptic throughout. The malignant growth diminished in size rapidly, the discharge became scanty, thin, and watery, and the ability to speak and swallow improved quickly. On the fifth day a portion of the growth on the right side sloughed out, leaving an aperture bounded by sloughy tissue, at the bottom of which could be seen necrosed bone in the lower jaw. Nine days after the operation profuse hæmorrhage took place, with a fatal result. This hæmorrhage was caused by sloughing of some of the diseased starved tissue, into which the trunk common to the facial and lingual passed.

In the second case no hæmorrhage or sloughing followed on the ligature of the external carotids. For two months the state of the patient was much improved, the growth showed but little tendency to increase, and the pain and dysphagia did not return. Then profound cancerous cachexia set in, with emaciation and loss of strength, beyond which there is no note.

v. Hæmorrhage from Middle Meningeal Artery after trephining.—This matter has been considered at p. 179, and more fully *Guy's Hosp. Rep.*, vol. xliii., where it is shown that severe hæmorrhage is not uncommon after a wounded middle meningeal has been exposed by trephining, but that the bleeding will usually yield to measures short of ligature of the external carotid.

GUIDE.—The anterior border of the sterno-mastoid above the hyoid bone.

RELATIONS.—The external carotid extends from the upper border of the thyroid cartilage to a point midway between the external auditory meatus and the condyle of the jaw; beyond this point it is continued on as the temporal, having just before given off the internal maxillary. In the first part of its course the external is somewhat nearer the middle line than the internal carotid, and is more superficial than this throughout.

IN FRONT.

Skin; fasciæ; platysma; nerves from transverse cervical and facial; superficial veins.
Lingual and facial veins.
Digastric and stylo-hyoid.
Parotid, facial nerve; temporo-maxillary and other veins.

INSIDE.	OUTSIDE.
Pharynx.	Parotid.
Hyoid bone.	Temporo-maxillary vein, when this descends to join the internal jugular.
Ramus of jaw.	
Parotid.	

External
carotid.

BEHIND.

Parotid gland.
Superior laryngeal.
Glosso-pharyngeal.
Stylo-glossus and stylo-pharyngeus.

The veins in relation with the external carotid vary a good deal. But, in addition to the lingual and facial crossing it, a number of veins joining the external and anterior to the internal jugular may form a kind of plexus round the artery, and the temporo-maxillary may descend outside the artery to join the internal instead of the external jugular.

BRANCHES :*—

ANTERIOR.	POSTERIOR.	ASCENDING.	TERMINAL.
Superior thyroid.	Auricular.	Ascending pharyngeal.	Temporal.
Lingual.	Occipital.		Internal maxillary.
Facial.			

Operation.—This is performed at two spots:

a. Below the digastric (Fig. 102).

b. Above this muscle, behind the ramus of the jaw.

a. **Below the Digastric.**—This is the operation more frequently performed in order to cut off the blood-supply through all the branches of the artery. Though these are so numerous, and vary somewhat, there is usually a spot, from $\frac{1}{2}$ to $\frac{3}{4}$ inch, between the superior thyroid and the lingual on which a ligature may be safely placed, especially if the superior thyroid and linguals are ligatured as well (p. 511).

The position of the patient's head and of the surgeon being the same as at p. 598, an incision $2\frac{1}{2}$ to 3 inches long is made, in the line of the artery, from the angle of the jaw to the upper

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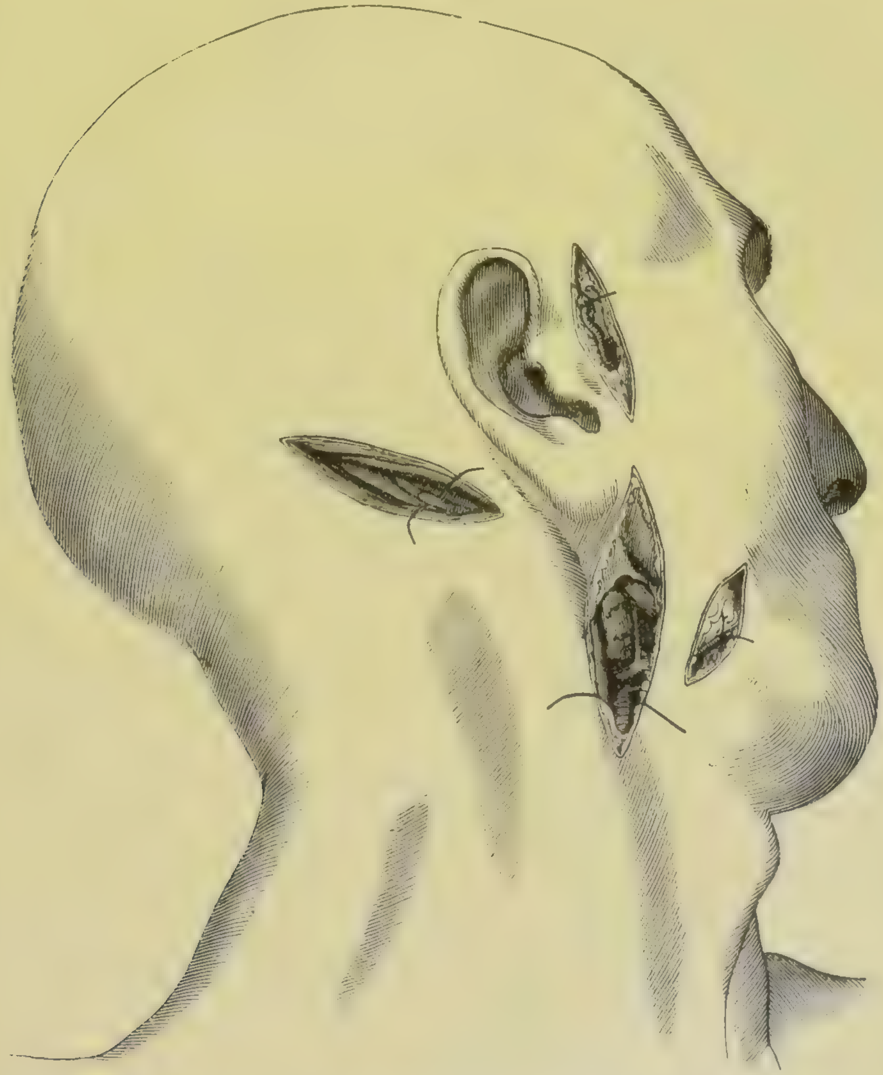
[*] While this is a common arrangement, it is by no means the only one. Very frequently one trunk gives off two or three arteries. Sometimes all the branches, save the two terminal, arise very close together, the external carotid constituting then an arterial axis. It is the presence of these branches which enables the surgeon to decide whether he is dealing with the external or internal carotid.

border of the thyroid cartilage, about ¼ inch in front of the anterior border of the sterno-mastoid. This incision should divide skin, fasciæ, and platysma; any superficial veins being secured, the cellular tissue in front of the muscle is opened up, and the

FIG. 102.



Ligature of the temporal, facial, external carotid, and occipital artery is shown here. In the ligature of the external carotid, the angle of the jaw, digastric, and opened deep cervical fascia are seen above. Overlying the artery is an enlarged lymphatic gland; outside it is the inner edge of the sterno-mastoid; the facial vein crosses it, and descending to join this on the inner side is a large communicating branch from the internal maxillary vein. The occipital artery is shown ligatured behind the mastoid process. The edges of the cut posterior half of the sterno-mastoid are shown in the upper and lower parts of the wound. Above the artery, under the upper part of the thread, is a part of the splenius capitis, cut. The vessel itself rests on some fascia continuous with that over the complexus.

osterior belly of the digastric or the hypo-glossal sought for as uides to the vessel. In doing this the sterno-mastoid should be rawn outwards, any large veins—*e.g.*, facial or lingual—pulled side with a strabismus hook or secured with double chromic-gut gatures before division. The muscle or the nerve being defined, the pulsation of the artery is felt for below them, and the vessel carefully cleaned just above the thyroid cartilage. The use of the steel director or knife should be most cautious on the outer side of the artery, where lie, below, the internal jugular and internal carotid. At the same time the presence of the descendens noni on the artery is to be remembered, and that of the superior laryngeal nerve running obliquely downwards and inwards behind the vessel. The needle should be passed from without. The superior thyroid and lingual should be ligatured at the same time, and the ascending pharyngeal if it can be found.

b. **Above the Digastric, behind the Ramus of the Jaw.**—This operation has the disadvantage of probably entailing the division of important branches of the facial nerve.

The head and shoulders being duly raised and supported, the surgeon makes an incision downwards from the tragus of the ear, just behind the ramus of the jaw, dividing the skin and fasciæ. The sterno-mastoid must be now drawn outwards and the digastric and stylo-hyoid downwards, and it will probably be needful to divide these latter muscles partially in order to secure the artery before it enters the parotid gland, this structure being drawn upwards and forwards.

The needle may be passed from either side as is most convenient to the surgeon.

Several veins communicating between the facial and the external jugular will probably cross the line of incision, and must be dealt with.

LIGATURE OF THE INTERNAL CAROTID.

Indications.—These are extremely few.

1. Wounds, usually Stabs.—The following striking case is quoted by Dr. Lidell,* and reflects the greatest credit on the medical men concerned :—

On July 31, 1869, a man was wounded in the neck, at the angle of the lower jaw, by the large blade of a pocket-knife, which penetrated several inches, opening the internal carotid. Alarmed by the tremendous outjets of arterial blood, Dr. Denning, in whose drug-store the stabbing occurred, at once compressed the carotids. Happening to be close at hand, Dr. A. T. Lee promptly cut down upon the artery by the usual incision, exposed it by careful dissection, found the bleeding point, and applied a ligature on the cardiac side of it. Hæmorrhage now occurring from the upper end was arrested by a ligature on the distal side of the wound. The patient was now pulseless, and death was considered imminent, but, under energetic stimulation with whisky and ammonia, the circulation soon became good, and the patient made a good recovery, being in active work nine years later.

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* *Intern. Encycl. of Surg.*, vol. iii. p. 111 ; *Amer. Journ. Med. Sci.*, January 1879, pp. 142, 143.

2. Aneurism.*—If this is non-traumatic† in origin and sacculated, the decision as to treatment, if pressure has failed, must lie between the Hunterian operation of ligaturing the common carotid, or, if the artery is sound, and if there be room above as well as below the aneurism, of placing ligatures above and below the sac, and opening this to turn out the clots. But one or both of these conditions may very likely be absent.

If the aneurism be traumatic, resulting from a stab or gunshot injury in the neck, or if, in spite of other treatment, it is steadily increasing, the only operation likely to avail is the old one.

The following cases are excellent instances of the difficulties which may be met with in these cases, and how they should be dealt with :—

Dr. Prewitt, of St. Louis (*Trs. Amer. Surg. Assoc.*, vol. iv. p. 233), has recorded the following most interesting case of traumatic aneurism :—A negress, aged seventeen, was shot with a revolver bullet, which entered the cheek over the malar bone and passed backwards. Profuse hæmorrhage took place at once from the wound of entrance, there being none of exit. This was controlled by pressure. A swelling quickly appeared between the ramus of the jaw and the mastoid process, which three months later was found to project into the pharyngeal cavity, crowding the tonsil over the middle line and resting against the uvula.‡

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* Aneurism of the internal carotid here refers to the cervical part of the artery. The treatment of orbital aneurism, which often depends on arterio-venous communication (traumatic or idiopathic) between the internal carotid and the cavernous sinus, has already been considered at p. 491.

† The rareness of disease, and thus of idiopathic aneurism, here is well known.

‡ With reference to this tendency of internal carotid aneurisms to project inwards, Dr. Prewitt thus quotes from Prof. Agnew (*Surgery*, vol. i. p. 591) :—"The deep situation of the artery, covered as it is externally by the stylo-hyoid, stylo-pharyngeus, and stylo-glossus muscles, and by dense aponeurotic structures, which extend down to the styloid process, prevents any very marked prominence of such a tumour on the surface of the neck, and, as the artery is separated from the pharynx only by the mucous membrane and the constrictor muscle, its extension inwards becomes an anatomical necessity. Indeed, in this peculiarity lies the chief difference between aneurism of the internal carotid and aneurism situated at the division of the common trunk."

Externally the swelling reached from the temporal bone to the hyoid. Expansile pulsation, well-marked bruit, and thrill were present. Sense of taste was lost in the right side of the tongue, which was atrophied, and, when protruded, inclined to the right. Pressure on the common carotid arrested pulsation in the tumour, and caused some decrease in size. There was no perceptible difference in the right and left temporal pulses; the pupils were equal. There was persistent headache, and sometimes roaring in the right ear. Difficulty in swallowing had existed from the first. The general condition was unsatisfactory.

It was decided to tie the common carotid at once, but though the pulsation and thrill in the sac seemed arrested at first, they returned in a few minutes. It was then decided, as a forlorn hope (because the diagnosis had placed the opening of the sac close to the carotid foramen), to extend the incision upwards in front of the tragus to determine the feasibility of laying open the sac, and tying the vessel upon the distal side of it.

A cautious dissection * at the back and upper part of the sac showed that this filled all the space between the mastoid process behind and the condyle and ramus of the jaw in front, the sac seeming also to blend with the skull or to be closely adherent to it. A little reflection made it apparent that any attempt to deal with the sac after the method of Mr. Syme would in all probability prove disastrous, as it would almost certainly be found that there was no portion of the artery between the carotid foramen and the sac to be tied. The wound was washed out with bichloride solution, drained, and closed. On the evening of the eighth day, there having been pyrexia and free suppuration of the wound in the interval, hæmorrhage took place from the sac. The wound was enlarged, and search made with the finger for the orifice of the artery or the carotid foramen. The search being fruitless, and it seeming certain that laying open of the sac or removal of the finger would be followed by speedily fatal hæmorrhage, the sac was packed with strips of lint rolled in iodoform. Hæmorrhage did not recur, but the patient died exhausted twenty-five days after the first operation.

The autopsy was conducted under great difficulty, but it was thought that it was made out that the opening in the artery was

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* It was suggested by Prof. Agnew, at the discussion on this paper, that the jaw should have been divided and the pieces pulled aside to facilitate further dissection, but Dr. Prewitt found that the jaw and sac were closely adherent, and, even if separation could have been effected, there would have been no artery above that could have been tied.

close to the carotid foramen. Death seemed largely due to septic causes—*e.g.*, thrombosis of the inferior petrosal and of the lateral sinuses.

Dr. Prewitt points out that such an aneurism might be mistaken for one of the occipital, vertebral, and perhaps of the internal maxillary or one of its branches. The chief diagnostic points are the projection into the pharynx, the evidence of pressure on the vagus and glosso-pharyngeal (p. 518), and the exclusion of the vertebral, by the effects of pressure below the sixth cervical vertebra (p. 523). He also shows by several cases that aneurism of the internal carotid has repeatedly, owing to the interference with speech and swallowing, the pain in the neck, and the difficulty in opening the mouth, been taken for tonsillar abscess, and with fatal results. One of these cases may be quoted here:—

A man, aged twenty-eight, was shot, on September 30, 1879, through the right infra-orbital region. No hæmorrhage. At the end of a week the swelling in the face had entirely subsided, but tumefaction of the right side of the neck remained. On the eighth day the patient was out. On the fifteenth he called at Dr. Lee's office, and complained of inability to speak or swallow, and also of severe pain in the right side of the neck, which he said he could not bend. His appearance was that of a man suffering from severe tonsillitis. With considerable difficulty Dr. Lee succeeded in opening the patient's mouth enough to permit of limited inspection. The tonsils and soft palate were so swollen as to preclude inspection of the pharynx. On the hard palate there was a small firm tumour about the size of a hickory-nut. Thinking this might be the ball surrounded by inflammatory products, an exploratory incision was made. On the removal of some clots of blood, there was a gush of arterial blood. In consequence of the struggles of the patient, Dr. Lee was unable to control the hæmorrhage, and death ensued in a few minutes.

In the discussion which followed on Dr. Prewitt's paper, the following case of traumatic aneurism of the internal carotid following a stab in the neck was related by Dr. Briggs, of Nashville:—

A man, aged twenty-three, had an expansile tumour in the left parotid region, encroaching on the throat, causing difficulty in swallowing. There was a loud bruit, and pulsation in the swelling was lessened by pressure on the common carotid. A small cicatrix pointed to the receipt of a stab six weeks before.

Acting on the principle that a traumatic aneurism is simply a wounded artery, and should be treated as such, Dr. Briggs performed the old operation. A knife being pushed into the most prominent part of the swelling, this opening was plugged with a finger, which appeared to find the wound in the artery. The opening being enlarged upwards and downwards, large clots were removed, followed by a gush of arterial blood, which was arrested by stuffing the wound with sponges. The incision being prolonged downwards, the common carotid was tied. On the removal of the sponges, the hæmorrhage was as violent as before, and was only arrested by the pressure of a finger in the sac. While this was kept up, the tissues were scratched through, and a ligature placed above and below the opening. Though the incision measured 8 inches, there was scarcely sufficient room. At the bottom of the wound the styloid process could be seen, and just anterior and internal to it the ligatures on the internal carotid. The patient made a good recovery.

It will be seen that the two cases of Dr. Prewitt and Dr. Briggs differ widely. Though both were traumatic, in one there was room to place a distal ligature,* in the other there was not. The fact that, in the latter, hæmorrhage did not recur for the twenty-five days in which the patient lived after plugging the sac, leads one to hope that plugging with aseptic gauze, firmly and carefully against the base of the skull, might be successful in such another case, if the wound could be kept aseptic, and the dysphagia met by tube-feeding.

LINE AND GUIDE.—These are practically the same as those given for the common carotid. The internal carotid lies outside and rather behind the external carotid. Soon after its commencement it becomes too deeply placed to admit of ligature.

RELATIONS IN THE NECK:—

IN FRONT.

Skin; fasciæ; platysma.
Sterno-mastoid; stylo-glossus; stylo-pharyngeus.
Glosso-pharyngeal nerve.
Parotid gland.

OUTSIDE.

Internal jugular.
Vagus.

INSIDE.

Pharynx.
Ascending pharyngeal.
Tonsil.

Internal
carotid.

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* Dr. Briggs, in replying (p. 256), said that, though the opening in the internal carotid was very close to the carotid canal, not more than ½ inch from it, the operation was not so very difficult.

Behind.

Rectus capitis anticus major.
Superior laryngeal nerve.

Operation.—This is much the same as that for ligature of the external carotid. The artery can only be tied in its first and more superficial part. It here lies outside and rather behind the external carotid.

Thus the incision should be made along the anterior border of the sterno-mastoid, and not just in front of it, the centre of the incision lying about ½ inch above the upper border of the thyroid cartilage. The sterno-mastoid being defined, and the cellular tissue opened up in front of it, the same superficial structures will be met with as in the external carotid (p. 513). When the carotids are found, the external should be drawn inwards, and the digastric upwards. The needle should be passed from without inwards, avoiding the internal jugular and the vagus.

LIGATURE OF THE VERTEBRAL ARTERY.

Indications.

(1) Wounds, (2) Traumatic Aneurisms, may be considered together. There is liable to be much obscurity as to whether it is the vertebral or some other artery—*e.g.*, inferior thyroid, ascending cervical, common carotid, or, if higher up, the occipital—which is attacked, and, when it is decided that it is the vertebral artery, it is by no means easy to carry out satisfactory treatment. The best course is to enlarge the wound, and to decide, with the finger, the relation of the wounded vessel and of the hæmorrhage to the transverse processes of the vertebræ. The direction of the wound, and the effect of pressure below and above the level at which the vertebral ceases to be compressible—*i.e.*, above the "carotid tubercle" (*vide infra*)—will also be helpful.

If the wound is low down, there are between 2 and 3 inches of the artery available for ligature, and this should be placed above and below the wound. But if, as is more frequent, the wound is higher up in the neck, it will be almost impossible, even after exposing and clipping away the anterior roots of the transverse processes, to find and secure the artery, and the best course will be to plug the wound, as successfully done by Dr. Kocher, of Berne.*

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* Langenbeck's *Arch. f. Klin. Chir.*, Bd. xii. S. 867. A full abstract of the paper is given in the *Syd. Soc. Bien. Retr.*, 1871–72, p. 202.

A man, aged forty-eight, had been stabbed in the neck. Daily hæmorrhages, often profuse, took place for three weeks, in spite of plugs of charpie soaked in perchloride of iron. On admission into the hospital a wound was found about an inch to the left of the spine, at the level of the fifth and sixth cervical vertebræ. Through the wound was seen a swelling, feebly pulsating. On removing coagulum and opening up the wound, free arterial hæmorrhage came from a cavity about the size of a small apple, at the bottom of which transverse processes could be felt. The bleeding came both from the central and peripheral ends of the artery, between the transverse processes of apparently the fifth and sixth vertebræ. As a ligature could not be applied, a pea-like bit of charpie, soaked in solution of iron perchloride, was introduced between the transverse processes. The head was kept fixed with a stiff collar. On removal of the plug on the fourth day, partly with a stream of water, partly with forceps, no bleeding followed. The patient was discharged cured in five weeks, having had a slight attack of erysipelas.

In the above paper Maisonneuve is said to have tied both the vertebral and inferior thyroid arteries, and removed a bullet. The hæmorrhage was arrested, but death occurred from purulent infiltration into the spinal canal. This appears to have been a case of ligature of the artery before its entrance into the vertebral canal.

Aneurisms of the vertebral are always traumatic. There are about twenty-four [*] cases on record of aneurisms and wounds of this vessel. The situation varies much. Usually it is high up, near the mastoid process.[†]

The difficulty of diagnosis of wounds of the vertebral and other arteries, and their results, has been already alluded to. Mr. Holmes (*Lancet*, July 26, 1873) states that there are eleven cases in which the carotid has been tied for wound or aneurism of the vertebral, of course with no advantage. This mistake seems to have arisen from forgetfulness of the fact that, while pressure on the common carotid below the transverse process of the sixth cervical vertebra will check all pulsation in the carotid, the branches of the carotid, and aneurisms situated on them, it will also check pulsation in a vertebral aneurism. Mr. Holmes points out that the above "carotid tubercle" is higher up than is usually supposed, being situated 2 to 3 inches above the clavicle, and he lays down the rule that, when a traumatic aneurism is situated in the course of the vertebral, and its pulsations are commanded, however completely, by pressure on the common carotid low in the neck, it ought not to be treated as being carotid, or as affecting a branch of the carotid, until it is clearly proved that its pulsations are stopped by pressure applied above the level at which the vertebral ceases to be compressible—*i.e.*, above Chassaignac's carotid tubercle. Ligature of the vertebral artery in the first few inches of its course being so very rarely available, compression of the artery low down, with the aid of an anæsthetic if needful, and with the additional help of direct pressure or cold on the aneurism above, should be made use of.

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[*] Barbieri, of Milan, quoted by Kocher (*loc. supra cit.*), has collected sixteen; Pilz (Langenbeck's *Arch. f. Klin. Chir.*, Bd. ix.) has gathered together four. Then there is Kocher's, one by Lücke in the same *Arch.*, Bd. viii. S. 78, and the American case given below.

[†] In nine, according to Kocher, the wound was at or above the second cervical vertebra; in two, "at the upper part of the neck;" in six it was below the second cervical vertebra. In four of the latter it was in the neighbourhood of the external carotid artery and its branches; thus in one the wound was at the angle of the jaw.

Dr. Weir (*New York Archives of Medicine*, 1884) records a case of a man stabbed on the right side of the neck, about ¾ inch below the ear, just in front of the sterno-mastoid. A traumatic aneurism, believed to be of the vertebral, slowly developed. Digital pressure over the carotid tubercle was made use of, and in three hours the tumour was cured.

If pressure fails, and if the aneurism increases in size, the surgeon must decide between running the risk of injecting ergotine, or throwing in coagulants, or opening the swelling and plugging it. In the latter case aseptic gauze strips—viz., iodoform or sal alembroth—should be made use of in preference to the perchloride of iron. The gauze should be carried into the aneurism, the wound being opened sufficiently freely to allow the surgeon to see what he is about, and the head should afterwards be kept rigidly still.*

(3) Ligature of the Innominate Artery, either at the same time to prevent Secondary Hæmorrhage, or, later on, to arrest this when it has occurred at the seat of Ligature owing to the Reflux of Blood from the Subclavian (p. 545).

(4) Epilepsy.—Dr. Alexander, of Liverpool, has performed this operation in thirty-six cases, after the first case usually tying both arteries simultaneously. The following (*Dict. of Surg.*, vol. ii. p. 786) is his opinion of the value of the operation:—

The operation was performed in the hope that a lessened supply of blood to the hinder brain and spinal cord would result in a diminution of cessation of the epileptic convulsions, it being expected that the diminution would be more permanent to the parts supplied after ligature of the vertebrals than after ligature of other vessels, on account of the absence of anastomosing branches, and the restraints to dilatation of the unligatured vessels by the long canals through which the vessels pass. For a time these expectations were realized, but soon relapses occurred, and in May 1884 an analysis of thirty-six cases showed only eight cases which have had so few fits since operation that they may be practically considered cured. Eleven were for several months so much improved that they seemed to be cured; and although the fits have recurred in all, yet the improvement is still distinctly manifest in many. In sixteen cases there did not seem to be any decided improvement. Three died out of the thirty-six—one from hæmorrhage, one from embolism, and one from pleurisy. All the cases operated on were chronic, hopeless epileptics, many of whom had become, gradually, mentally affected. Not one of the latter was permanently benefited to any practical extent. On account of the uncertainty as to what cases will derive benefit from the operation, Dr. Alexander has ceased to recommend or perform the operation. As far as he can at present see, this chapter of surgery may be closed.

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* In one case related by Kocher the nerves lying behind the artery were njured, and, in another, dangerous inflammation of the spinal meninges took place.

Relations.—The vertebral artery, the largest and usually the first branch of the subclavian, arises from the upper and back part of the artery, and ascends at first a little outwards and backwards to reach the foramen in the transverse process of the sixth (sometimes the fifth or seventh) cervical vertebra. Traversing these foramina, it passes through that of the axis; it then bends outwards and upwards to reach that of the atlas, and then passing backwards lies in a deep groove on the posterior arch of the atlas behind the articular process, beneath the sub-occipital nerve. In this position it lies in the sub-occipital triangle. Finally, it pierces the posterior occipito-atloid ligament and dura mater, and, running upwards and forwards through the foramen magnum, winds round to the front of the medulla to join its fellow and form the basilar at the lower border of the pons Varolii.

Behind.
Cervical nerves (in vertebral canal).
Sympathetic plexus.

Outside.
Scalenus anticus and phrenic nerve.

Inside.
Longus colli.

Vertebral artery.

In Front.

Internal jugular.
Inferior thyroid.
Thoracic duct (left side) crossing from
within outwards.
Vertebral vein.
Sympathetic plexus.

Operation.—The head being suitably raised and turned slightly over to the opposite side, an incision, 3 inches long, is made along the outer border of the sterno-mastoid, extending to the clavicle. In deepening this incision, the external jugular must be looked out for, running parallel, here, with the outer border of the muscle. When the deep fascia is divided, the sterno-mastoid, together with the vein, is to be drawn inwards, the incision being prolonged along the clavicle, and some of the clavicular fibres detached from the bone if needful. The surgeon then, working with the narrow point of a steel director, carefully opens up the deep connective tissue, and endeavours to define the interval between the scalenus anticus and the longus colli muscles; as the outer border of the former muscle corresponds with that of the sterno-mastoid, this muscle must be well retracted inwards. In defining the vertebral artery as it lies between the scalenus and longus colli, the presence of the phrenic nerve lying on the scalene, the pleura internally, the internal jugular, inferior thyroid, and the vertebral veins over the vessel, with the thoracic duct crossing it, on the left side, from within outwards, must all be borne in mind, these structures being drawn to either side, as is convenient, with strabismus hooks. The depth of the wound and venous hæmorrhage are difficulties at this stage. The needle is then passed from without inwards. Owing to the deep position of the artery, a good light is essential, and the head must be manipulated so as to relax the deep parts as is required. The anterior transverse tubercle in the sixth cervical vertebra is a good guide in cases of difficulty; below it, the pulsation of the artery should be felt. In cleaning the artery previous to passing the ligature, the fibres of the sympathetic must be disturbed as little as possible. Temporary paralysis from the interference with these fibres is almost certain, and immediate contraction of the corresponding pupil is of very frequent occurrence, and may be regarded as a pretty certain indication that the vessel has been secured. If the vertebral vein is wounded and cannot be secured separately, ligatures should be placed on artery and vein together, above and below the wound in the latter.

It has been suggested by Dietrich to tie the vertebral artery between the atlas and axis. This operation would prevent the reflux of blood from above after a wound or traumatic aneurism below had been plugged; but however feasible as a dissecting-room operation, it would be one of great difficulty on the living, owing to the depth and small part of the artery which is to be tied.

LIGATURE OF SUBCLAVIAN.

As it is very doubtful whether ligature of the first part is a justifiable operation even in these days of improvements in aseptic surgery and of new ligatures, the operations on the second and third parts will be described first, the two being taken together, as one operation is often only an extension of the other. The operation on the first part will then be more briefly alluded to (p. 536).

LIGATURE OF SUBCLAVIAN IN ITS SECOND AND THIRD PARTS (Fig. 100).

Line.—From the curved and short course of this vessel no definite line can be given.

Guide.—The chief point to remember is the outer margin of the sterno-mastoid, as this corresponds to the outer border of the scalenus anticus, which has to be defined and then traced down to the tubercle on the first rib, the part of the artery to be tied lying on the upper surface of this bone, outside and behind the muscle and tubercle.

Relations (third part) :—

In Front.

Skin; fasciæ; platysma; branches of cervical plexus.
Venous plexus—viz., external jugular; supra-scapular; posterior scapular; transverse cervical; branch from cephalic.
Transverse cervical and supra-scapular arteries.
Cellular tissue and fat.
Nerve to subclavius.
Subclavian vein (below).

ABOVE.
Omo-hyoid.
Cords of brachial plexus.

Subclavian
(third part).

BEHIND.
First rib.

RELATIONS (second part) :—

IN FRONT.
Skin ; fasciæ ; platysma.
Sterno-mastoid.
Scalenus anticus.
Phrenic nerve.

ABOVE.
Cords of brachial plexus.

Subclavian artery
(second part).

BELOW.
Pleura.

BEHIND.
Scalenus medius.

Collateral Circulation.

When a Ligature is applied to the Third or Second Part.—Three main sets of vessels* are here employed—viz.,

ABOVE.		BELOW.
The supra-scapular, The posterior scapular,	with	The acromio-thoracic, the infra-scapular, sub-scapular, and dorsalis scapulæ.
The superior intercostal, The aortic intercostals, The internal mammary,	with	The long thoracic, and scapular arteries.
Numerous plexiform vessels passing through the axilla from branches of the subclavian,	with	Branches of the axillary.

When a Ligature is applied to the First Part.—The collateral circulation may be carried on by the superior anastomosing with the inferior thyroid, one vertebral with its fellow, the internal mammary and superior intercostal with the long thoracic and scapular arteries, and the princeps cervicis with the profunda cervicis (Smith and Walsham, p. 38).

Indications.

i. In some cases of axillary aneurism—*i.e.*, those in which, owing to the pain, the irritability of the patient, the depth of the artery, the rapid increase of the aneurism—pressure is not available.* With regard to the operation of ligature of the subclavian for axillary aneurism, it should be remembered that the mortality is high. Mr. Holmes † thus explains this fact:—In the first place the procedure resembles Anel's operation almost as much as Hunter's. Hence, suppuration of the sac from loose formation of clot, and secondary hæmorrhage from disease of the artery, may be anticipated. Again, the ligature must be placed in the immediate vicinity of large branches. Then, again, the deficient formation of laminated clot is further favoured by the absence or loose structure of the aneurismal sac, and by the want of resistance in the parts which surround it. Mr. Erichsen (*Surgery*, vol. ii. p. 212) also alludes to the unfavourable results after ligature of the subclavian for axillary aneurism: *i.e.*, out of forty-eight cases, twenty-three were cured and twenty-five died; and attributes the high mortality chiefly to three causes—viz., (1) inflammatory changes within the chest; (2) suppuration of the sac; (3) hæmorrhage. See below, p. 531, where the chief points in the after-treatment are given.

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* Key, *Guy's Hosp. Reports*, 1836. A case in which the subclavian artery had been tied for axillary aneurism twelve years previously.

ii. Cases of subclavian and subclavio-axillary aneurism not amenable to other treatment; or where the aneurism, especially if subclavio-axillary, is small in size (not larger than a hen's egg), of recent duration, and distinctly traumatic in origin. Mr. Poland (*Guy's Hosp. Reports*, 1871), in his report on subclavian aneurism, gives nine cases of recovery and twelve cases ending fatally after ligature of the second or third portions of the subclavian for subclavian or subclavio-axillary aneurism. With regard to the nine successful cases Mr. Poland raises a very important question. Was the aneurism developed in a healthy artery? If so, the success is explained. In three the aneurism was entirely local, independent of general arterial disease. In two this was doubtful. In four the origin was spontaneous. Whether general atheroma existed here must remain uncertain, as the patients recovered, and the artery, where tied, was healthy. "We can only say this, that subclavian aneurism in its early stage, occurring in persons of the early or middle period of life, without any indication of disease of the heart or large vessels, may and does recover, and that a cure may be effected by means of a ligature of the third or second portion of the artery notwithstanding the disease is one of spontaneous origin, and therefore presumed to be indicative of arterial disease." In these successful cases the size of the aneurism in no case exceeded that of a hen's egg, and the duration of the cases was short, being under four and a half months.

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* See the conclusions on axillary aneurism formulated by Mr. Holmes in his "Lectures at the College of Surgeons," p. 107.

† *Syst. of Surg.*, vol. iii. p. 109.

Of the twelve unsuccessful cases of subclavio-axillary aneurism there was good reason to believe that in ten at least an atheromatous condition of the arteries existed. The size of the aneurism was, in all save one, larger than in the first group.

iii. As a distal operation, together with ligature of the common carotid for some cases of aneurism of the innominate and aorta. See p. 561.

iv. Preparatory to such operations as removal of the scapula (p. 139).

v. For wounds of the subclavian itself—*e.g.*, stabs. This is very rarely called for.

Operation for Ligature of the Third or Second Portion of the Subclavian (Fig. 100).—These two will be considered together, as one operation is but an extension of the other.

The patient being turned over on to the sound side, propped up with pillows at the edge of the table, the head drawn over to the opposite side, the shoulder on the side of the aneurism is depressed as strongly as possible, so as to open out the posterior triangle. The surgeon then, standing in front of the shoulder, draws the skin down over the clavicle with his left hand, and makes an incision, 3 inches long, over this bone, between the sterno-mastoid and trapezius, dividing skin, fasciæ, and platysma. The soft parts being now allowed to glide up, the incision should lie ½ inch above the clavicle, the external jugular vein thus escaping injury, for as this vein perforates the deep fascia just above the clavicle, it cannot be drawn down with the skin, superficial fascia, and platysma. If more room is required, owing to the elevation of the clavicle or the presence of an aneurism, the above muscles must be divided, and a longitudinal incision made upwards, at right angles to the inner end of the first, and a triangular flap raised outwards and upwards.

When the superficial parts have been sufficiently incised, the deep fascia is carefully opened at the inner end of the incision and laid open on a director, and the areolar tissue beneath, which varies much in density and the amount of fat which it contains, scratched through in a direction aiming for the outer edge of the scalenus anticus, which corresponds to the outer margin of the clavicular part of the sterno-mastoid. As soon sa the deep fascia is divided, the presence of the following complications must be remembered and provided for. The soft tissues may be much matted, œdematous, and altered owing to previous use of pressure or inflammation set up around a rapidly growing aneurism. The venous plexus formed by the external jugular receiving the supra-scapular and transverse cervical veins, and, often, the posterior scapular and a branch over the clavicle from the cephalic as well, may be much engorged. Any one or more of these veins which are in the way should be drawn aside with a strabismus hook or aneurism needle, or divided between two chromic catgut ligatures. Owing to the free anastomoses, this latter course is to be adopted without hesitation if needful. It cannot be insisted upon too strongly that a bloodless wound will best enable the surgeon to reach this often most difficult artery, and a bloodless wound is best secured by tying beforehand every vein which cannot be drawn out of the way, and by using a fine-pointed steel director as much as possible after the deep fascia is opened.

As a rule, the transverse cervical artery is above the incision, and the supra-scapular below it, under the clavicle, but occasionally one or both of these may be found lying across the field of operation, and must then be drawn aside with a strabismus hook. While the veins may be ligatured without hesitation, the arteries must be preserved intact, that the collateral circulation may not be interfered with (p. 527).

The omo-hyoid varies in position, and may be neglected.

The outer edge of the scalenus anticus being defined by scratching through the cellular tissue, this muscle is to be traced downwards to the scalene tubercle on the first rib, immediately above and behind which landmark lies the artery. One of the lowest cords of the brachial plexus will now come into view, and must not be mistaken for the artery, a contingency otherwise not unlikely to happen, as the lowest cord is in close contact with the artery, and may receive pulsation from it.* A little cleaning will show the fasciculation of the nerve, while the artery is closer to the rib, and is flat, not rounded, when rolled under the finger.† By compressing the artery between the needle passed beneath it

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[*] Mistaking a cord for the artery, or tying the two together, has happened to excellent surgeons. Thus, in a case under the care of Mr. Green, of St. Thomas's Hospital, one of the cords was included in the ligature. The agony produced was extreme; the man did not cry out, but the expression of his face was something most appalling. The ligature was immediately loosed, and the artery alone tied, and all the frightful symptoms disappeared. The man made a good recovery, and was seen many years afterwards perfectly well (Poland, *loc. supra cit.*, p. 83).

[†] Another difficulty about the pulsation is its variableness. Sometimes it is violent and excited; at others, as in the case of a dilated and diseased artery, or one much handled in the operation, almost imperceptible.

and his forefinger, and noting the result of this pressure on the aneurism and the pulse below, the surgeon will clear up any doubts as to whether he has the artery or no.

The position of the artery being made sure of, the sheath* is opened with the point of the knife, the artery cleaned, and the needle passed from above downwards and from behind forwards. This best avoids the worst risk—*i.e.*, of including a nerve cord. The needle should be kept most carefully close to the vessel, and not dipped suddenly or used with any force; otherwise the pleura or subclavian vein may be injured.†

The artery, before the ligature is tightened, will be inspected with some anxiety as to its condition—whether normal in size and structure, or if dilated, thickened, or thinned.‡ If much alteration is found, the surgeon should carefully divide the outer half of the scalenus anticus on a director with a blunt-pointed bistoury, sponging the wound absolutely dry so as to watch for the phrenic nerve, which, if seen, should be drawn inwards with a strabismus hook.

If the artery is found diseased here also, the surgeon should use a flat ligature of ox aorta or kangaroo-tail tendon, and endeavour so to adjust the tightening of the ligature as not to divide both the internal and middle coats (p. 540).

In cases where the wound is a very deep one, care must be taken while making the second knot that the first does not slip. The ligature having been tightened and cut short, drainage is provided and the wound carefully closed and dressed. The limb is then bandaged with cotton-wool and kept somewhat supported, and the temperature maintained with hot bottles if needful.

The Chief Points in the After-treatment are—(i.) keeping the wound rigidly aseptic, (ii.) arresting hæmorrhage, (iii.) meeting suppuration of the sac, (iv.) combating the stiffness and weakness of the limb which sometimes follow on ligature of the main trunk.

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* A process of deep cervical fascia which the vessel brings out from between the scaleni, and one which varies much in density.

† The surgeon should be provided with needles of different curves and a silver probe with a large eye. As pointed out by Sir W. Fergusson (*Surgery*, p. 607) with his attention to details in operations, the eye of the needle should always be close to the point, that the ligature may be at once seized with forceps as soon as it appears under the vessel, the difficulties at this stage of the operation being not only the surrounding parts of importance, but also the fact that in this case the handle cannot be depressed as freely as in operations on most other arteries, and thus it is difficult to make the point rise above the vessel.

‡ In a case of Liston's the vessel was dilated, thick, and soft, "aptly enough compared to the finger of a buckskin glove." The patient, aged forty-three, died of hæmorrhage on the fourteenth day. In a patient of M. Jobert's (Poland, *loc. supra cit.*, p. 110) "the vessel was found enormously large, equal to the size of an aorta; pulsation being very marked."

(i.) This need not be further alluded to in a work like this, but it cannot be too strongly insisted upon that, if the high mortality (p. 535) which has hitherto attended this operation is to be reduced, it is mainly to keeping the wound aseptic throughout, and thus to early primary union, that we must look.

(ii.) The risk of hæmorrhage is so great that the surgeon should always endeavour to prevent it by trying to obtain early and firm closure of the wound as just indicated, and by keeping the patient absolutely quiet till all is soundly healed. When once hæmorrhage occurs, the outlook is very grave. The treatment must vary according to the size of the wound which remains. If there be only a sinus, firm pressure must be made over the dressings by well-adjusted bandaging, aided by a heavy bag of shot or a truss-like instrument adjusted for the purpose.*

If the wound is larger, and perhaps septic and sloughy, an anæsthetic should be given, and, any clots being removed, the wound should be gently swabbed out with a solution of zinc-chloride (gr. 20 or 40 to water ℥j), or with iodoform and ether, the wound then dried, dusted with iodoform, and pressure applied as above; or the wound may be plugged with strips of aseptic gauze, the part placed within the wound having been wrung out of turpentine, or with sponges of appropriate size and texture which have been kept in a solution of carbolic acid (1 in 40), and are now wrung dry and dusted with iodoform, silk being attached to the deeper ones before they are inserted. The patient should be kept as quiet as possible with morphia; the diet should be restricted and given at regular intervals, and without stimulants unless absolutely required. The cases collected by Mr. Poland (*loc. supra cit.*, pp. 116, 117) show that, while hæmorrhage may occur as early as the eighth day, it may be deferred till the twenty-sixth or forty-sixth day, the ligature having come away on the twentieth day in either case. In neither of these two latter cases had the wound healed: in the first, the patient had been allowed to get up; in the second, pyæmia was present.

The same writer (*loc. supra cit.*, p. 125) thus sums up the sources of hæmorrhage:—

(*a*) *From the sac*, either *primary* from puncture in the operation, or *secondary* from ulceration or rupture at an early period, or later after inflammation and suppuration and giving way of the sac.

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* In a large hospital, where relays of assistants are available, digital pressure may be made use of.

(*b*) *From the ligatured part*, in consequence of non-obliteration of the artery when the ligature is becoming detached, the hæmorrhage being generally from the peripheral end of the artery tied. It may be due also to an unsound state of the coats of the artery, such as dilated, thinned coats or atheromatous degeneration.

It is worth remembering that this hæmorrhage is, in exceptional cases, recovered from. Mr. Poland (*loc. supra cit.*, p. 127) quotes four cases from the collection of Kocher which recovered after the use of styptics, pressure, and cold, and adds one under the care of Sir W. Fergusson (*Edin. Med. and Surg. Journ.*, 1831, p. 309), in which the hæmorrhage was arrested promptly and for good by pressure applied immediately by the patient's wife.

(iii.) Suppuration of the sac. The frequency of this untoward accident has been already alluded to (p. 528). It is due to the close proximity of the ligature to the sac, without any intervening branch, whereby the necessary coagulum is but ill-formed and loose, acting as a foreign body, and setting up irritation, inflammation, and its consequences.

Every endeavour should be made to prevent its occurrence by forbidding all handling of the aneurism.

If evidence of it occur, and the swelling, which has at first diminished in size, again about the second or third week steadily increasing in size, becomes tense and painful, but without pulsation, it must be opened by a sufficiently free incision, carefully emptied of pus and clots, drained, and well-adjusted pressure applied. If the wound has not healed, and particularly if it has become septic, hæmorrhage is extremely likely to occur after opening the sac—an ominous complication, which can only be met by plugging with aseptic sponge or gauze, and using firm pressure (p. 532).

(iv.) Atrophy, stiffness, and weakness of the limb. These must be met by warmth, use of electricity, and, above all, by perseveringly used massage.

The condition which is so common in the lower extremity after an analogous operation (see Ligature of External Iliac), in which the limb long remains in a state not far removed from gangrene, is much less common in the upper extremity.

Difficulties and Accidents which may be met with, and Points to avoid, during the Operation.

1. Sterno-mastoid and trapezius almost meeting.

2. A short full neck with much fat both above and beneath the deep fascia.

3. Clavicle much pushed up. This may be due to the patient having carried his shoulder raised to relieve the painful pressure on the nerves, or to the presence of an aneurism.

4. The artery may be displaced. This deviation from its usual course may be acquired, as in a case of Warren's (Poland, *loc. supra cit.*, p. 77), where the left subclavian was raised and displaced by a curvature of the spine in a woman aged thirty, the subject of an aneurism (attributed to strain), about the size of a pigeon's egg, just above the scapular end of the clavicle. Ligature was performed by an incision made obliquely from the outer edge of the sterno-mastoid towards the acromio-clavicular joint, the pulsation of the artery being the guide. Congenital deviations which have been met with are the artery perforating the scalenus anticus, or lying in front of it, or, as usual, behind this muscle, but now closely accompanied by its vein.

5. The soft parts infiltrated, œdematous, or matted together owing to the presence and irritation of an aneurism, aided, perhaps, by previous attempts at cure by pressure.

6. Great engorgement of the veins met with here, due to the presence of an aneurism, and increased by the anæsthetic.

7. Aneurismal sac very prominent and liable to be punctured in the operation. This accident took place even in the hands of the elder Travers. The sac was as large as a swan's egg, and pulsating strongly. The patient died on the third day after the operation with effusion into the right pleura. The ligature was firmly seated on the artery at the root of the sac and adjoining the outer edge of the scalenus. The sac had a pouch-like enlargement upwards, which closely overlaid the artery on the pectoral side; and this, having been penetrated in the passage of the needle, had occasioned the profuse arterial hæmorrhage without saltus, which was not arrested by the tightening of the ligature, and which was only controlled by introducing a sponge tent into the wound. The same accident is stated by Mr. Erichsen to have happened to Cusack while ligaturing the subclavian for a diffused aneurism of the axillary artery. The alarming gush of blood which took place was arrested by plugging the wound, but the hæmorrhage recurred fatally on the tenth day.

8. Wound of the supra-scapular artery necessitating ligature of this branch. As a rule this artery lies too low down to be injured—a complication to be extremely deprecated, as it is one of the chief channels by which the collateral circulation is estab-

lished (p. 527). In about one out of every three cases the posterior scapular will be found to arise from the third part of the subclavian as a separate branch. Erichsen (*Surgery*, vol. ii. p. 208) advises, if this condition be met with, that the ligature be applied, as far as possible, " to the proximal side of the branch. If necessity obliges the ligature to be applied close to the branch, it is perhaps safer to tie this also, as the anastomosis of vessels in this region is so abundant that the risk of gangrene from the obliteration of a single branch would be very small." But, according to the post-mortem examination of a case in which Mr. Key had tied the artery twelve years previously for axillary aneurism, the posterior as well as the supra-scapular are very important channels by which the blood is carried into the axillary through the infra-scapular (*Guy's Hosp. Reports*, 1836).

Any artery crossing the subclavian should be, normally, the transverse cervical. This or any other vessel which may be an artery should be drawn aside with a strabismus hook.

9. Pulsation in the artery, weak or deficient, or, on the other hand, excited and tumultuous (p. 530).

10. Including a cord of the brachial plexus (p. 530).

11. Injuring the pleura. This has happened on several occasions during the passage of the needle round the artery, owing to the close proximity of the serous membrane to the vessel, and the difficulty in passing the needle, especially when the clavicle is much raised, rendering it impossible to pass the needle from below, and thus away from, the pleura.

Erichsen (*loc. supra cit.*, vol. ii. p. 212) considers inflammation of the contents of the thorax to be the most frequent cause of death, proving fatal in 1 out of every 2.5 cases. This is not pyæmic, but arises from causes essentially connected either with the operation or with the aneurism itself. "These are referable to three heads. (1) Septic inflammation of the deep areolar tissue at the root of the neck may extend to the anterior mediastinum, the pleura, and pericardium. . . . . (2) The sac may, by its pressure inwards, encroach upon, and give rise to inflammation of, that portion of the pleura which corresponds to its posterior aspect. This occurred in a case in which Mayo, of Winchester, operated, and is more liable to happen if suppuration have taken place in the sac; when this occurs, adhesion may take place between this and the pleura, or even the tissue of the adjacent lung, and the contents of the suppurating tumour may be discharged into the pleural cavity or air-tubes, and so coughed up. Of this curious mode of termination there are at least two cases on record—one by Bullen, in which the patient recovered; the other by Gross, in which the patient died from the escape of the contents of the sac into the cavity of the pleura. (3) Division of the phrenic nerve would necessarily, by interfering with the respiratory movements, induce a tendency to congestion and inflammation of the lungs, and although such an accident must be a very rare one in cases of ligature of the subclavian for axillary aneurism, yet it undoubtedly has occurred, as I have myself witnessed in one case."

12. Injuring the nerve to the subclavius or including it in the ligature. This nerve, derived from the junction of the fifth and sixth cervical, usually gives a filament to the phrenic. If, as occasionally happens, this filament is replaced by a nerve constituting an important part of the origin of the phrenic, injury to it will be followed by urgent and speedily fatal dyspnœa.

13. Injury to the subclavian vein. This is rare, as the vein lies below and well away from the artery. But if ligature was called for in a case in which the vein accompanied the artery between the scaleni, this deviation would prove embarrassing.

I have spoken at p. 531 of division of the scalenus anticus if the surgeon does not find the part of the artery beyond this muscle healthy. It is not needful to speak at length and separately of this step, as it is a mere extension of the operation for ligature of the third part, the muscle being also only divided in part. Mr. Poland (*loc. supra cit.*, p. 128) points out that, of eight cases in which the scalenus was partially divided, five recovered, and that of these five recoveries the operation was on the left side. These cases thus fully prove that a ligature may be placed on the second part of the artery without fear of want of thrombus formation or of injury to important parts.*

LIGATURE OF THE FIRST PART OF THE SUBCLAVIAN.†

As this operation has been performed by surgeons of the highest eminence, and as it affords good practice on the dead subject, it will be given here. It seems most doubtful, however, whether the improvements of modern surgery aided by recently introduced ligatures will ever render this a successful operation, failing as these advantages almost certainly will to meet that secondary hæmorrhage which has proved so fatal from the distal side of the ligature, owing to the facility with which the numerous collaterals bring in blood to this spot.

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* As shown by Mr. Poland, the remarks of Porter on the numerous and great perils of this operation are scarcely borne out—viz., the phrenic on the scalenus anticus; the thoracic duct lying, on the left side, at the inner edge of the muscle; the three large branches usually given off by the subclavian while between the scaleni; and the close proximity of the first dorsal nerve behind the artery.

† These remarks refer to the right subclavian. A ligature has certainly once been placed on the first part of the vessel on the left side, Dr. Rodgers, of New

Mr. Erichsen, who gives what he calls an "appalling" table of fourteen cases, all fatal, condemns the operation as "bad in principle" and "most unfortunate in practice," and considers that it should "be banished from surgical practice."

RELATIONS.—These, owing to the greater depth of the artery on the left side, must be given separately.

IN FRONT.

Skin; fasciæ.
Sterno-mastoid; sterno-hyoid; sterno-thyroid.
Internal jugular and (often) vertebral vein.
Vagus; phrenic; cardiac nerves.

Right subclavian (first part).

BEHIND.

Recurrent laryngeal; sympathetic.
Longus colli; pleura (and beneath).

IN FRONT.

Sterno-mastoid; sterno-hyoid; sterno-thyroid.
Pleura; lung.
Vagus; phrenic; cardiac nerves.
Internal jugular; innominate veins.
Common carotid.

OUTSIDE.

Pleura.

Left subclavian (first part).

INSIDE.

Trachea.
Œsophagus; thoracic duct.

BEHIND.

Sympathetic.
Œsophagus; thoracic duct.
Longus colli.

York, being the operator, and losing his patient from hæmorrhage on the fourteenth day. Mr. Erichsen (*loc. supra cit.*) states that Sir A. Cooper failed in an attempt to secure the vessel, and that he is said to have wounded the thoracic duct. See also Mr. Banks' remarks, p. 553.

Operation.—This resembles ligature of the innominate. The following account is taken from Mr. Barwell :*—

A triangular flap having been turned upwards and outwards, and both heads of the sterno-mastoid divided, the anterior and, if needful, the external jugular veins are secured with double chromic-gut ligatures, and cut. The fascia over the sterno-hyoid being exposed, "the director, after a little opening in the aponeurosis has been made, can be insinuated behind that muscle, which also must be severed. It is well now to look and feel for the carotid artery before going on to divide the sterno-thyroid, whose outer edge covers that vessel, and never, as far as my experience of the dead subject goes, conceals the subclavian."† The finger of the operator, after division of the sterno-hyoid, readily detects the longitudinal course and pulsation of the carotid, and may with ease push the edge of the sterno-thyroid from off its sheath inward, in which position the muscle should be held with a blunt hook. When thus the sheath of the vessel is brought into view, the operator should look for the large veins that always, but more especially if there have been dyspnœa, overlie it. Choosing a vacant spot, he merely nicks the loose structure in which they lie, and then pushes them up and down, tearing the cellular tissue a little, till the dense fibrous sheath is bared sufficiently—first, to have a small opening made in it, and then to be slit up. This should be done on the front and inner aspect. Now, at this part, the vein diverges a little from the artery, so as to leave a triangular interval, through which the vagus runs. A blunt hook is placed over this, and it is to be drawn with the jugular vein gently outward. The next point is to find the subclavian. To do this the operator must remember that the usual description and delineation of the innominate bifurcation is incorrect. It is generally depicted as if the two branches rose side by side and almost at right angles to each other. In reality, the subclavian springs behind the carotid, and the angle between the two vessels is very acute. Therefore, to detect the subclavian, the operator must place his finger at the back and outer part of the carotid, when, passing it down, he comes, generally a few lines above the clavicle, to the slightly

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[*] *Intern. Encycl. Surg.*, vol. iii. p. 513.

[†] "The mere division of the muscle is in itself unimportant, but there lies behind it a plexus of large veins, passing from the thyroid body to the internal jugular, generally distended by the dyspnœa accompanying aneurism at the root of the neck. Their division causes profuse bleeding and subsequent difficulty in recognising the deeper parts."

divergent pulsating line of the subclavian, which lies deeper than the carotid by the whole diameter of that vessel.

In selecting the spot for placing the ligature, it is well not to put it quite close to the bifurcation, but also not too near the scaleni, lest the recurrent laryngeal or the phrenic should be injured. The vagus and the jugular vein should be kept, not too forcibly, outwards, and the needle should be passed from below, while with his left forefinger the surgeon gently presses the pleura downward and outward. Some obstruction behind the artery will very likely be encountered, but it is better gently and patiently to overcome this, and never on any account to attempt to pass the needle the other way; for if this be attempted, the instrument is certain to penetrate the pleura. Having now passed and tied the ligature, the surgeon should consider the advisability of also securing the vertebral. It lies in the groove between the longus colli and scalenus, so that the jugular vein must now be held inwards; the dissection already made will have so nearly exposed the artery that a few touches with a director will lay it sufficiently bare to allow the passage of the needle. The position of the phrenic nerve on the anterior scalene, outside and a good deal in front of the vessel, guards it against much risk of injury, but still it must be carefully avoided. The operator must not mistake the inferior thyroid (which is, however, much smaller, and usually at this part external) for the vertebral* itself.

LIGATURE OF THE INNOMINATE (Figs. 100, 103).

Owing to the fatality of this operation, the question arises whether it is justifiable or no. There have certainly been nineteen cases, and in only three † have the patients survived.

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* "In certain cases the aneurismal sac overlying the vertebral artery renders it inaccessible."

† One of these is the well-known case of Dr. Smyth, of New Orleans (*Syd. Soc. Bien. Retr.*, 1865–6, p. 346). The second, under the care of Mr. Mitchell Banks, has never been published. I am enabled, through his courtesy, to give this case below, p. 551. A third successful case of ligature of the innominate has been published by Dr. Lewtas, of the Indian Medical Service (*Brit. Med. Journ.*, 1889, vol. ii. p. 312). While this case shows what skill and coolness can effect in a terrible emergency, and while it proves that a catgut ligature in a healthy innominate will withstand the force of the blood coming *a tergo*, it must be remembered that the subclavian aneurism here was a traumatic one, and the patient only twenty. A month before his admission a piece of the breech of a bursting gun had lodged above the right clavicle. A swelling, about the size of a fœtal head, occupied the lower part of the posterior triangle, hard to the touch and not pulsating. From a partially healed wound brownish blood had been oozing for three days. As the man was anxious for removal of the foreign body, and as the case seemed to be

The extreme danger of the operation is due partly to difficulties which may be met with at the time of its performance—difficulties which have driven most skilful surgeons to abandon the operation—but chiefly to the frequency of secondary hæmorrhage.

In an operation which must be performed at such long intervals it will be some time yet before we know how far modern antiseptic surgery is able to diminish the above mortality, with the absence or diminution of suppuration, the more rapid healing, the firmer thrombosis, and the improved ligatures. Sir J. Lister, speaking of antiseptic ligatures in 1869, wrote thus sanguinely: "For my own part, I should now without hesitation undertake ligature of the innominate, believing that it would prove a very safe procedure." Two cases have recently been fully reported—viz., Mr. Thomson's and Mr. Bennet May's. In spite of all the care taken, and the use of modern ligatures, neither case ended successfully. Mr. Thomson's case died on the forty-second day, of hæmorrhage, which began on the thirtieth day. It was believed that the sinus which resulted from the drainage-tube became septic, and that the pus had ulcerated into the innominate at a point quite unconnected with the ligature, the latter, ox aorta furnished by Mr. Barwell, having disappeared. Mr. May's case died of secondary hæmorrhage on the nineteenth day, caused by the large and very hard knot, which had been tied in the ligature used, ulcerating into the vessel (p. 542).

The question which *ligature* is best suited to a large trunk like this, very likely diseased, with blood possibly impelled into it by the closely adjacent heart, and with collateral circulation certain to be quickly set up along the carotid and vertebral, is still unsettled.* And not only this question, but others which arise with it are still

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one of deep cervical suppuration, the opening was enlarged sufficiently to admit the little finger, and a fragment of steel, weighing 3 drachms, removed with dressing-forceps. This was followed by an alarming rush of blood, so profuse as to render impossible discovery of the bleeding point. Fortunately, the finger detected the opening in the subclavian behind the scalene, and by pressure an assistant thus arrested the hæmorrhage. The man's condition being desperate, it was decided to tie the innominate and carotid. This was done by an incision along the inner border of the sterno-mastoid and notching the sterno-hyoid and sterno-thyroid. The two vessels were secured with "catgut ligatures." A drainage-tube was inserted into the extensive cavity of the original wound, some of the coagula which filled this being removed. The patient made a good recovery. It is much to be regretted that this case, so creditable to the operator, has been published so briefly, especially with regard to the size and kind of the catgut used, and the means taken (if any) for draining the wound by which the arteries were tied.

* This question is discussed later (p. 543).

awaiting answer, viz., *the tightness with which the ligature should be tied and the advisability of using a drainage-tube.* None of these points can be considered settled, in spite of excellent work, both clinical and experimental, which has been done in this direction. With regard to the former, numerous cases, especially those of Mr. Barwell, have proved that, if ox aorta or kangaroo-tail be properly prepared, their contact with the soft tissues they surround will be unirritating, and that, infiltrated by wandering cells, they will be gradually absorbed, new rings of fibrous tissue forming in their place. Mr. Barwell's cases of ligature of the carotid and subclavian for innominate aneurism have also established these points—(α) that ox aorta may be so tied as not to divide the inner coat;* (β) that this ligature may produce as permanent and complete obliteration as any silk ligature. Mr. Banks' case (p. 551) also encourages the further use of these ligatures, as kangaroo-tail tendon was used in this, the only case in which a patient has recovered without hæmorrhage after ligature of the innominate for non-traumatic aneurism. I am of opinion the above cases fairly prove that these ligatures, if properly prepared and tied with sufficient tightness, are free from any tendency to slip prematurely or lose their hold from the knot becoming soft or untied, an objection which could fairly be brought against the catgut ligatures when first re-introduced some years ago. I do not think that another objection brought against them by Mr. Holmes is a valid one. "Mr. Barwell's ligature is, no doubt, flat when laid on a table, but when tied it is hard to see how its sharp edges can be prevented from impinging on the vessel, and if they do they will probably cut the middle coat." With all due respect to such an authority, and speaking only from an experience of two vessels, the innominate and the carotid (p. 554), I think the extreme suppleness which half an hour's soaking in a tepid solution of hyd. perch. or carbolic acid brings about in these ligatures removes any risk of "sharp edges." When tying such a vessel as the innominate the surgeon must have several ligatures reliably prepared, as their breaking is still an accident to be prepared for.

Thus in Mr. May's case the needle—an old-fashioned silver one, flexible, well rounded at the point, and with a large eye—having been passed satisfactorily round the vessel, "was threaded with a small cord, to which a strip of ox-aorta material, kindly sent me by Mr. Barwell, was attached, and by it pulled through. In tightening the tape, I had to draw the ends with very considerable force to stop the pulsation, the vessel offering great resistance and pulsating with great force. Just at the critical moment, however, the material gave way and broke across, and a second piece introduced in a similar manner suffered the same fate. I then endeavoured to imitate the principle of the flat ligature by using a cord made up of five or six medium-sized threads of catgut. This bore the strain very well, and, after tightening with sufficient force to completely stop pulsation in the tumour and branches of the carotid, I drew on the ends still further to allow of some subsequent relaxation in fixing the knot. At the same time I endeavoured to avoid crushing the coats of the artery. The ligature was secured with a third knot, and cut short." The patient died of hæmorrhage on the seventeenth day, and it was found that this very precaution, taken with all care and thoughtfulness by Mr. May, had tended to bring about the fatal result. "The ligature still retained a firm hold on the vessel; one or two of the threads were partially absorbed and softened, but others scarcely changed. The knot, unfortunately very large and hard, was quite unaltered. Under the knot, in the front of the vessel and in the line of a fold or bend of its wall, was the obvious source of the hæmorrhage, in the form of a ragged hole about the size of a small pea; this opened into the vessel on both sides of the ligature." Mr. May goes on to say that the further appearances were instructive in view of the debateable questions surrounding the use of animal ligatures. With the exception of the hole corresponding to the knot, no part of the arterial wall was injured or divided, though under the ligature itself the wall was thinner than elsewhere. The inner coats were intact. It was obvious that the small chink which remained between the crumpled-up folds of the vessel, the remainder being occluded by adhesion of the inner coats, was closed by a moderately firm clot. A similar clot with conical end extended along the distal side of the artery nearly to its bifurcation. On the heart side there was a thin diaphragm of clot with a conical end, but it extended a very inconsiderable distance. As the bulk of the hæmorrhage no doubt occurred here, some of the clot may have got carried out during life. The hole in the wall of the artery having been closed, it was shown, by injecting water, that the vessel was wholly occluded at the seat of ligature.

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* It is right to point out that another case of the same surgeon proves that, in attempting not to divide the inner coat, the surgeon may fail to close the vessel at all.

Turning from the results which bedside work has given to those of experiment, we are struck by the diametrically opposite conclusions at which workers have arrived as to the most useful form of ligature and the best means of tying it. This, though at first embarrassing, will be of less importance to those who, like myself, hold that any evidence drawn from ligature of arteries in animals is of little value when applied to those of man. It is not only that (as we have daily opportunities of seeing) wounds and injuries in animals heal more readily and with much less risk of sepsis than in man, but evidence drawn from ligatures of *healthy* arteries in *healthy* animals must be received with much caution, the difference being very wide indeed between these cases and those where a ligature has to be applied in man for an aneurism, in patients past middle life, and with vessels no longer sound. Finally, any one who has tied the innominate in man for aneurism will hesitate to accept conclusions drawn from ligatures of like material, and tied in like manner, on the carotids of sheep and horses. In addition to the objections already given, the two wounds are totally different. In the case of ligature of the carotid in animals we have a vessel which can be tied in healthy parts, well known for the rapidity with which they heal, and a wound which can be made with very slight disturbance of the soft parts. In the innominate, on the other hand, we have an operation beset with difficulties, often involving, from the presence of an aneurism, much displacement of parts, and a wound from its position, with its deepest part behind unyielding bone, most difficult to drain efficiently. I have spoken above of the diametrically opposed results at which those who have worked at the experimental side of this question have arrived. This is shown by the papers of Mr. Ballance and Mr. Edmunds, "The Ligation of the Larger Arteries in their Continuity: an Experimental Enquiry" (*Med. Chir. Trs.*, 1886, p. 443), and Mr. Spencer's "Experiments on Ligature of the Innominate" (*Brit. Med. Journ.*, 1889, vol. ii. p. 73). The first-named writers have arrived at the following conclusions:—(1) That the operation of ligature of a large artery in its continuity should be performed without damage to its wall. (2) That the rupture of the coats of an artery during ligation in continuity is a useless and dangerous proceeding: useless, because the surgeon can secure the effectual occlusion of the vessel by a measure at once safer and less severe; and dangerous, on account of the possible occurrence of hæmorrhage or secondary aneurism at the seat of ligature, which could not happen if the wall of the vessel were uninjured by the ligature. (3) That, if the artery be diseased, the advantages attending ligation without rupture of the tunics are much magnified. It sometimes happens that the surgeon, on cutting down upon a large artery, observes a state of atheroma so extensive that he is obliged to close the wound and ligate a vessel nearer the heart, and thus expose his patient to considerably increased risk. There is no escape from such a dilemma under the system which declares that the arterial coats must be divided; but with a non-irritating aseptic ligature, so applied as not to lessen the power of the arterial wall, but actually to be a source of additional strength to it, the question of ligation is seen under entirely new auspices, and the occlusion of a diseased artery would be undertaken with an assurance of success almost equal to that which obtains when a healthy vessel is in question. (4) That, when the coats of an artery are uninjured by the ligature, the danger of ligation near a large collateral branch is wholly avoided, because—(A) No danger can accrue from hæmorrhage when the wall of the vessel is intact; (B) The formation of clot, upon which the safety of the patient so much depends if the wall of the vessel be damaged, has really nothing to do with the adhesive changes which take place in a ligatured vessel; (C) The plastic actions which proceed at the place of ligation are practically alike, whether the tunics be ruptured or not. (5) That the ligatures employed in this series of experiments were probably in all cases larger than was absolutely necessary to secure the obliteration of the vessels. Comparatively speaking, they were not large. It would appear that a small round antiseptic ligature which will not become absorbed in less than three weeks, and which during that period holds firmly so as to cause a constriction of the arterial wall, and complete, or almost complete, obstruction of the cavity of the vessel, will so influence the nutrition of the part that permanent occlusion will follow. (6) That it is no more necessary to use a flat tape-shaped ligature (as recently revived by Mr. Barwell to prevent damage to the arterial coats during ligation) than to rupture the coats of the vessel. The small round ligature is the most easy to manipulate, and it is not difficult to learn to apply it in the manner here indicated.

On the other hand, Mr. Spencer, from his experimental ligatures of the innominate in monkeys, concludes, as to the ligature and the mode of applying it, that the best ligature is one of Chinese twist silk which has been kept in 5 per cent. carbolic acid, and boiled in that solution before being used. A silk ligature can be thus "rendered more thoroughly aseptic than any other without injuring its strength, and, being aseptic, it will remain quiet in position without relaxing. The ligature should be tied tight to divide the internal coats. All recent experiments agree in showing that the more antiseptic a ligation, the less the amount of coagulum, the more dependence to be placed upon the scar tissue which ensues on dividing the internal coat for closing the artery."

The truth is that these cases of ligature of the innominate in man are too few and far between to give us, for a long time, the only evidence on which we can rely. All other requires most careful weighing and checking before it is accepted.

At the present time, till we have further evidence bearing on the influence of modern surgery on this operation, we may say that there are cases which are clearly most inappropriate, and that there are certain special precautions which should not be neglected during and after the operation.

First, as to **selection of cases**, the following words of Mr. Holmes* should be remembered. The operation "should never be performed, however, unless the artery can clearly be felt healthy behind the sterno-clavicular joint,† or the tumour is so plainly limited as to afford a very reasonable hope that it will be found so. In cases of tubular enlargement of a long tract of artery in the neck, it is more than useless to expose an artery which will probably be found so diseased as either to prevent the operator from the attempt to tie it, or to give way and occasion fatal bleeding within a few hours if it be tied."‡

The following are amongst the **precautions** indicated:—

1. Rigid antiseptic precautions persevered with till the wound is soundly closed.

2. Use of a flat ligature in securing the innominate—viz., one of ox aorta or kangaroo tail—with care, if possible, that the knot is not a hard one and does not press strongly on the side towards the artery.

3. Securing the carotid artery at the same time.§ By this, in

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[*] *Syst. of Surg.*, vol. iii. p. 112.

[†] As Mr. Holmes remarks in a foot-note, "If the shape of the bones or joints is altered, it is clear that the aneurism arises in the thorax."

[‡] It is, however, very remarkable that in the cases of Porter and Aston Key, though it was found impracticable and undesirable to ligature the artery owing to its diseased and dilated condition, such changes were set up in the vessel by the exposure and manipulation as to lead to gradual cessation of the pulsation in the aneurism in one case, and its diminution in the other.

[§] Ligature of the common carotid at the same time as the innominate will not necessarily prevent hæmorrhage, as was shown by Smyth's case, in which the carotid was tied at the same time as the innominate. Hæmorrhage occurred on the fourteenth day, and was repeated at intervals. The vertebral was ligatured on the

Mr. Spencer's words (*l.s.c.*), "a thrombus is then formed in the proximal end of the carotid, which extends to the bifurcation, and thus aids a thrombus in forming in the first part of the subclavian as far as the vertebral; otherwise the blood-flow will pass from the subclavian to the carotid close by the distal side of the ligature of the innominate, and so the operation will lack one of the important characteristics of a Hunterian ligation."

4. Closing the wound as thoroughly as possible, so as to prevent formation and collection of discharges.

Mr. Thomson, in his exhaustive account of his own case, states his belief that the fatal ulceration into the innominate was brought about by decomposition of discharges collecting at the bottom of the sinus left by the drainage-tube. This decomposition was, he thinks, due to the difficulty of keeping the dressings firmly on a movable part like the neck, to the fact that the skin heals much more quickly than the deep parts, and that the clavicle assists in preventing the soft parts coming together. He would, in future, use carefully adjusted sponges and shot-bags over them.

5. Keeping the patient absolutely at rest till the wound is soundly healed, morphia being used subcutaneously, and any tendency to cough checked at once if possible.

LINE AND GUIDE.—The vessel, 1 to 2 inches long, extends along a line drawn from the middle of the junction of the first with the second bones of the sternum to the right sterno-clavicular joint (Holden). Its point of bifurcation varies somewhat.

RELATIONS :— IN FRONT.

Sternum; sterno-hyoid; sterno-thyroid.
Left innominate and right inferior thyroid vein.
Inferior cervical branch of right vagus.

OUTSIDE.
Right innominate vein.
Right vagus.
Pleura.

INSIDE.
Left carotid.

Innominate artery.

BEHIND.
Trachea.

Collateral Circulation.—These are thus given by Sir W. MacCormac (*Ligature of Arteries*, p. 75):—

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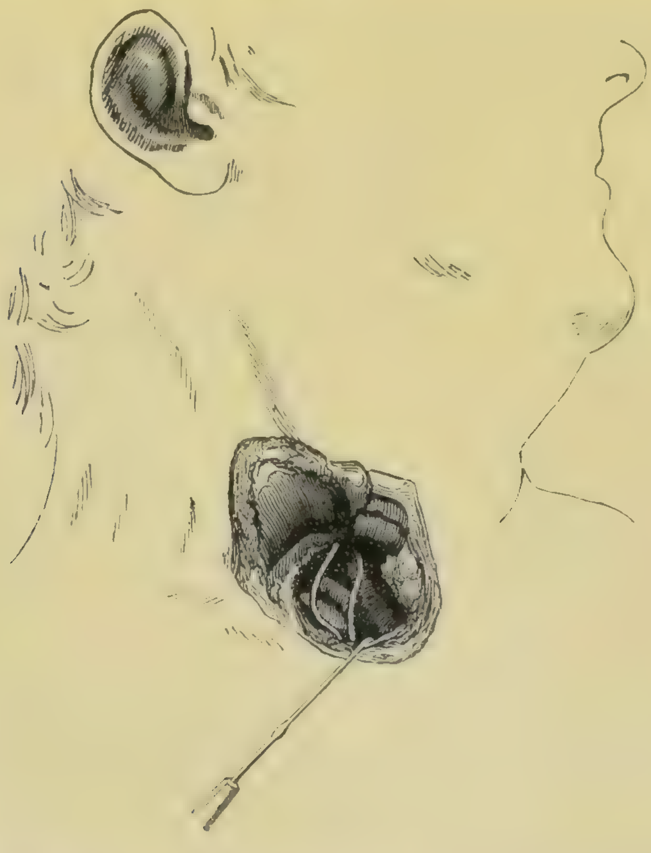
fifty-fourth day, and recovery ultimately took place. Of five monkeys in which Mr. Spencer tied the innominate, the only one in which the carotid had not been tied died from hæmorrhage.

	Cardiac Side.		Distal Side.
Trunk.	First aortic intercostal,	with	Superior intercostal of subclavian.
	Upper aortic intercostals,	with	Thoracic branches of axillary and intercostals of internal mammary.
	Phrenic,	with	Musculo-phrenic of internal mammary.
	Deep epigastric,	with	Superior epigastric of internal mammary.

Free communication of vertebrals and internal carotids of opposite sides inside the skull. Communication of branches of opposite external carotids in the middle line of the face and neck.

Operation.—The patient, having been brought into as satisfactory a condition as possible by preparatory treatment, the head, body, and arm are placed as in ligature of the subclavian (p. 529). The surgeon, standing in front, makes an incision along the inner third of the clavicle, and another along the anterior border of the sterno-mastoid, meeting the first at an acute angle, each incision being upwards of 3 inches long (Figs. 100, 103). The flap thus marked out is dissected up, the sternal and clavicular heads of the sterno-mastoid divided, and the sterno-hyoids and sterno-thyroids also carefully cut through on a director. This incision was made use of by Mott when he tied the artery in 1818. It appears preferable, as giving much more room in difficult cases, to any other. It has the serious disadvantage of dividing muscles which retract much and leave a large, gaping, deep wound, the difficulty of draining which has already been alluded to. I have mentioned one or two precautions which will, I believe, meet, in part, the above objection to this incision. Where the presence of a large aneurism with one or more processes to its sac increases enormously the difficulties of this operation, and thus calls for free access to the important parts dealt with, I am of opinion that this division of muscles will be found needful. Mr. Spencer, from his experiments on monkeys, advises the use of a single median, vertical incision, made as if for a low tracheotomy, retracting the sterno-mastoid, sterno-hyoid, and sterno-thyroid, opening the sheath and tying the carotid, and then following this down as a guide to the innominate. He argues rightly that if the muscles be retracted only, and not divided, when they are released, they will come together, so that no cavity is left in the deeper parts of the wound. Sound as this reasoning is, I fear there is no comparison between ligature of the innominate in monkeys and the same operation under the conditions which usually call for it in man. Every atom of room may be required, not only on account of the importance of the parts dealt with, the great enlargement of the veins, the presence of a dilated subclavian, a process of the aneurism extending inwards or a hugely expanded vertebral as in my case (p. 555), but also because the surgeon may feel bound, as I did, to give his patient the benefit of a less risky operation, and thus be driven to divide the sterno-mastoid in order to examine the fitness for ligature of the second part of the subclavian. I would advise division of the muscles (in a case of any real difficulty), but at a point 1½ inch above the clavicle. If they are divided just above this bone, the ends retract behind it, and I found the introduction of sutures impossible. My case also taught me that raising the skin and sterno-mastoid together, a precaution I adopted to secure a heavy flap, which will fall better into position, and thus help to close the deep wound, is a futile one, the contraction of the sterno-mastoid

FIG. 103.



Above, the two heads of the sterno-mastoid, the sterno-hyoid and sterno-thyroid are seen reflected. Two inferior thyroid veins cross the innominate. Another large vein is drawn down by the strabismus hook.

from above raising the skin with it. During these preliminary steps, one or two small arteries may be divided and some enlarged veins connected with the inferior thyroids drawn aside or tied with double ligatures, and, in reflecting the above-mentioned flap, the presence of the anterior jugular passing outwards beneath the sterno-mastoid just above the clavicle must be remembered.

The above muscles, when cut, being carefully held out of the way, and a layer of deep cervical fascia varying in strength divided, the pulsation of the carotid is defined, and its sheath opened to the inner side and as low down as possible. Other guides will be found, in the trachea and the subclavian, to lead the finger down to the innominate.

The carotid being traced down, the innominate will be found bifurcating into the carotid and subclavian (Fig. 103). It is now that the real difficulties may be met with. (1) Owing to engorgement of the venous circulation, increased by the anæsthetic, the internal jugular and innominate vein may be so much enlarged as to protrude into the wound. (2) An aneurism may have reached under the artery and flattened it out so as to make it difficult of recognition. (3) The cellular tissue around the vessel and between it and the sternum may be so matted with adhesions as to make it difficult to define the artery and its important relations on the right side—viz., vagus, pleura, and right innominate vein. (4) The artery itself may be enormously diseased and expanded. (5) The bifurcation of the artery may be quite an inch below the joint.

In tracing down the innominate itself, the surgeon must keep his steel director most carefully on the front of the artery. In following the vessel down behind the sternum in order to find a site for his ligature, he will be aided by slightly flexing the head and by a laryngeal mirror, or electric light. The cleaning of the artery must be done with the utmost caution, especially on the outer side, owing to the important structures lying there; of these the innominate vein and the vagus may be drawn outside, but it is only by keeping the director or needle-point very close to the artery here that injury to the pleura can be avoided.

If there is doubt as to the position of the artery, pressure with the finger behind the vessel against the sternum will arrest the pulsation in the carotid and the aneurism. If the bifurcation of the artery lie, as in my case, a full inch below the joint, attempts should be made, by pulling up the carotid protected by a piece of aseptic lint, to raise the bifurcation sufficiently for the passing of the ligature. I believe this to be preferable to dragging on the vessel by the ends of a ligature previously tied round the carotid, and left long. If it is impossible thus to raise the bifurcation sufficiently, the inner 1½ inch of the clavicle must be removed by disarticulating and sawing through the bone.

The needle should be passed from without inwards and a little from below upwards to avoid the pleura. In this case, as in that of the subclavian and other deep-seated arteries, the surgeon will do well to provide himself with needles of different curves (of these Mr. Durham's needle, in which the curve is twisted laterally at a right angle to the shaft, is a very helpful one), or with a silver probe sufficiently flexible to take any curve and with a large eye close to the point (p. 531).

The needle should be loaded with aseptic silk, and to this, after it has passed, a flat ligature, kangaroo tail or ox aorta, should be securely knotted, and then pulled beneath the vessel. It should be tied firmly, as I believe (p. 541) that these ligatures, after soaking, are so supple as not to cut into the vessel. Care should be taken to keep the ligature flat around the artery while tying it, and the knot as little projecting (especially towards the vessel) as possible. In addition to the amount of force used, the surgeon will derive some information as to the extent to which he has constricted the vessel by watching the aneurism, all pulsation in which should have ceased.

The ligature being tied and cut short, the common carotid should be tied also, about ½ inch above its origin. If the thyroidea ima arise from a point at which it is likely to bring in a reflux current which will dangerously disturb the clot, on which so much depends, this vessel should be tied also.*

The wound is now carefully cleaned and dried, the severed muscles carefully united with chromic-gut buried sutures, hæmorrhage most scrupulously stopped, a drainage-tube inserted,† and the wound carefully closed. If the patient will bear it, the limb, previously wrapped in cotton-wool, should be secured to the side and chest, and every attempt made, by elastic bandaging and aid of a shot-bag, to keep the dressings firmly in place, and thus promote, from the first, steady adjustment of the parts and sound healing. Morphia should be used as freely as is safe, to diminish, as far as possible, the sensibility of the patient to the irksomeness of his position. The slightest tendency to cough should be treated at once. The absolute need of rest and quiet should be enforced upon the patient until the wound is soundly healed.

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* This was the case in Lizars' patient (*Lancet*, 1837, vol. ii. pp. 445, 602; Spencer, *loc. supra cit.*).

† If it is possible to suture the cut muscles satisfactorily, and thus close the deepest part of the wound after this has been carefully dried out, a drainage-tube may be dispensed with. If the surgeon, wishing to be on the safe side, especially where the parts have been much disturbed, makes use of a tube, it should be removed, if possible, at the first dressing. I followed this course in my case on the day after the operation. When the patient died, on the tenth day, the wound was found at the autopsy perfectly sweet and free from any collection of fluid.

I am enabled, through the courtesy of Mr. Banks, to give an abstract of a most interesting case of right subclavian aneurism, in which the innominate and, subsequently, the first part of the subclavian were tied. Owing to the exceeding rareness of recovery after ligature of the innominate, and the survival of a patient for thirty-six days after the placing of a ligature round the first part of his subclavian, it is to be hoped that this most instructive case will soon be published *in extenso*.

J. B., aged fifty, was admitted into the Liverpool Royal Infirmary, February 10, 1883, with well-marked symptoms of aneurism of the third part of the right subclavian. Attempts to treat the patient by rest, &c., having failed, owing to his obstinately persisting in getting up, the innominate and common carotid were tied, February 26, with the strictest antiseptic precautions. The earlier steps presented nothing remarkable. "Unluckily, the bifurcation was quite ½ inch lower than it ought normally to be, and this caused some difficulty in getting the aneurism needle round the vessel. I used a needle of the ordinary kind, having a large curve, and threaded with silk. There was about a minute of rather anxious work while the needle was being tickled through the tissues surrounding the vessel, a proceeding which was accomplished solely by feeling, as the artery lay too deep for me to see anything that could aid me. By means of the silk thread, a stout kangaroo-tendon ligature was pulled beneath the vessel, then tightened, three knots being placed upon it. I applied the amount of force which I thought would be necessary completely to occlude the artery, but not to damage its coats, and I felt very certain that I had made a thorough and satisfactory ligature of the artery. Whether I really did so or not is a question. . . . . The aneurism ceased to pulsate. I next proceeded to pass a ligature round the common carotid. . . . . Being engrossed in this, I took no further notice of the aneurism. But those who were assisting saw that, after an interval of about two minutes, a certain amount of pulsation returned in the aneurism. I imagined that this must have arisen from the retrograde circulation along the common carotid and subclavian, and so proceeded at once to tighten the ligature (another kangaroo tendon) round the former vessel. As soon as this was done, the pulsation in the aneurism again became practically imperceptible."

A slight return of pulsation was noticed in the evening of the operation.

The restlessness and irritability of the patient during the first few days were frightful. He tossed about the bed, moved his arm as much as the bandages would allow, loudly demanded stimulants, and swore at everybody about him. He was not, however, in the least feverish or delirious. Practically there was never any suppuration, and the extensive wound healed by primary union. All dressings were discontinued on the thirteenth day, and the patient, who had insisted on getting up on the ninth, went out on the twentieth day with the wound sound.

Unhappily, the pulsation feebly present in the aneurism on the evening of the operation became strong and accompanied with thrill by the third day. Pressure with a bag of shot was tried, but the patient, by his unruly behaviour, did all he could to prevent any consolidation occurring. When the patient went out the aneurism was quite as soft, and the pulsation and thrill quite as obvious as before. It very soon decidedly increased, spreading out under cover of the trapezius and pushing inwards the scalenus anticus. "At the end of five weeks it became clear that either the aneurism must be left alone and the man abandoned to his fate, or that something more must be done. But what? Galvano-puncture and the introduction of wire or other material into the sac have not proved of sufficient utility to entitle them to be considered satisfactory methods of treatment at the present moment, whatever may become of them in the future. Ligature of the first part of the axillary on the distal side of the tumour is not any better. To lay open the aneurism and attempt to secure the artery on either side of the aneurismal opening would almost certainly have been fatal on the spot. To go down through the old cicatrix in search of the innominate, with a view of tying it a second time, seemed very impracticable. Besides, I could not be any more certain of curing the aneurism the second time than the first. The only thing that remained was to tie the first part of the subclavian. Sixty-seven days after the ligature of the innominate I performed this operation, not using the spray during the dissection, lest it should obscure one's vision, but turning it into the wound after the vessel was tied. By this date the tumour had so increased in size that there was just room on its inner side, and no more, to get at the artery. An incision was made along the hinder margin of the sterno-mastoid, and another extending from it outwards along the clavicle. After getting through the superficial structures, the clavicular portion of the sterno-mastoid was divided, and the internal jugular was followed down to its junction with the subclavian. Here, in consequence of the matting together of parts as a result of the first operation, it became almost impossible to know what one was dealing with, and an unpleasant accident occurred. I tore across a vein of some size close to the point where it entered the angle of junction of the jugular and subclavian. Instantly a rushing and hissing noise showed that some air had got into the venous trunks, and for a brief space the situation was uncomfortable. A finger was put on the aperture, and to our relief the patient showed no signs of being in any way affected by the occurrence. The aneurism covered by the thin fibres of the scalenus anticus next came into view. My colleague, Mr. Harrison, gently but steadily pushed this outwards with a couple of fingers, and in the very limited space between this and the internal jugular I proceeded to search for the artery, guided by its pulsation. Very slowly, and after an infinity of anxious picking and teasing (for one dared not use a knife), this was exposed about ½ inch from the aneurism. The vessel was obviously thinned and dilated, and this added immensely to the danger of passing the aneurism needle beneath it. The needle was threaded with a silk ligature, which drew after it a double catgut ligature. The loop of this being divided, the artery was secured by both portions lying side by side. The knots were drawn very gently, with the intention of merely closing the artery and not of injuring any of its coats. The aneurism at once became still.

" A very few lines have sufficed to describe this operation, but it took more than an hour to perform, while the difficulty, danger, and anxiety that attended it are almost impossible to describe. Owing to the fact that the parts had already been interfered with, there was a great deal of thickened and cicatricial tissue present. Cutting this was out of the question, as it was impossible to say what was adherent to or mixed up with it. It had, therefore, to be pulled asunder fibre by fibre, with the aid of strong forceps and a dissecting tool. As the operation advanced, the depth at which one had to work became greater and greater, while, in order clearly to make out the various structures, the wound had to be kept absolutely free from blood. Sometimes minutes would be lost in picking up some trifling vessel from which just enough blood would keep welling to obscure the wound. The space in which anything could be done was of the most limited description, and surrounded by dangers on every hand. To the outer side was the bulging aneurism, to the inner was the internal jugular, below lay the subclavian vein, and immediately beneath the artery itself was the pleura. . . . . Compared with this performance, tying the innominate was a mere surgical amusement, and I should never care to repeat it again."

The patient rallied well from the operation, but a few days later developed an attack of broncho-pneumonia, which exhausted him extremely. He slowly rallied from this, but the wound gaped widely. It ultimately healed, save for a sinus, which admitted a probe deeply. On the twenty-third day the patient got up, and by the thirty-first day had been out in the open air. On the evening of this day hæmorrhage occurred from the sinus, frequent recurrences took place, and the patient died on the thirty-seventh day after the operation. By the fourth day the aneurism had no trace of pulsation, and was small and hard.*

The following case of ligature of the innominate which was under my care well illustrates some of the difficulties which may be expected. A. H., æt. 48, was sent to me by Dr. Lockhart Stephens, of Emsworth, February 1890. Occupying all the lower part of the posterior triangle, and to be felt in the axilla and between the heads of the sterno-mastoid, was a large aneurism, 6 inches × 4 inches. There was no evidence that the innominate itself was involved. Patient had first noticed the swelling a year before, when it was about the size of a walnut. He had been doing his work as a gamekeeper, and shooting rabbits, till two weeks before his admission, February 10. Chloroform being given, the parts cleansed, and irrigation with hyd. per. 1-2000 employed throughout, an incision 3½ inches long was made along the anterior margin of the sterno-mastoid, and another transversely outwards, just above the clavicle, over both heads of the sterno-mastoid, to a point over the inner part of the aneurism. The skin and both heads of the sterno-mastoid were divided together, with the hope of thus keeping the skin down better when the wound was closed, and thus better obliterating the large wound and ensuring earlier healing. The sterno-hyoid and sterno-thyroid being divided, two very large inferior thyroid veins secured, and the internal jugular drawn outwards, the inner part of the carotid sheath was opened and this artery traced down to the innominate. The chief difficulty at this stage was due to what was thought to be a pulsating process of the aneurism, which extended inwards under the jugular and carotid, but was really a hugely dilated vertebral. The carotid being traced down, it was found impossible to pass a ligature below the bifurcation, which lay a full inch below the joint. In spite of the aid given me by Mr. Davies-Colley, who drew up the carotid protecting the vessel with a bit of lint out of carbolic lotion, I was unable to get my finger or a director sufficiently deep behind the clavicle to make sure of being below the bifurcation. I accordingly removed the inner extremity of the clavicle, disarticulating and sawing through the shaft. I was now able, aided by Mr. Davies-Colley's most efficient help, to bring just the top of the bifurcation into view. More than this was impossible, and the aneurism needle (one of corkscrew form lent me by Mr. Durham) was passed by touch round the innominate from without inwards. It was previously loaded with silk, to which a piece of ox-aorta ligature, kindly provided by Mr. Barwell, was knotted. In tying the vessel, I tried to use force sufficient to close it, but not to injure its coats. Judging from the outside, the walls were well puckered together. Pulsation in the aneurism ceased at once, and never returned. The carotid was then tied, with a similar ligature, about an inch above its origin, not only to prevent any efflux of blood through it, but also because the vessel was probably weakened by much handling. The wound was thoroughly dried out, and dusted with iodoform, a drainage-tube inserted, and the wound united by twelve salmon-gut sutures. By the third day the aneurism began to shrink markedly, but the following night the patient began to be restless and delirious, and this increased and persisted. The delirium was peculiar. He was incessantly restless, trying to get out of bed, chattering without ceasing, calling to his dogs, &c. It was most difficult to keep his right arm still, and before long it was needful to secure him with straps. Morphia, sulphonal, chloral, chloral-amide, hydriodate of hyoscyamin were all tried with very little result. There was also evidence of broncho-pneumonia at both bases. The restlessness and chattering delirium continued, and, in spite of the abundance of food taken, the strength became exhausted, and the patient sank on the tenth day. The wound remained quite sweet throughout. At the post-mortem examination the wound was perfectly sweet, without a trace of pus, and levelling up well. A large sacculated aneurism occupied the second and third parts of the subclavian and the first and second parts of the axillary. In addition to the main sac, which occupied the posterior triangle, a hemispherical dilatation projected into the upper part of the right pleura. Encircling the innominate, just below the bifurcation, which was on a level with the first costo-sternal articulation, was the remains of a ligature, but no knot could be found, and the ligature was movable with the point of a director. Surrounding the bifurcation of the innominate was a small cavity, from which could be squeezed not more than a drachm, if so much, of quite sweet pus-like fluid. The carotid had been tied about ¼ inch above the top of the sternum, and here, too, the wall of the vessel was very soft, so that in dissecting it a hole was made in the vessel above the ligature. The knot, however, had held well in position. Running behind the carotid sheath, and given off from the subclavian immediately after its origin, was a long fusiform dilatation, which was probably the vertebral much dilated, as large as the forefinger. A small window being cut in the aneurism showed that this was filled with a greenish-tinted, jelly-like coagulum, not blood-stained, and traversed in every direction by isinglass-like threads. The only remnant of a cavity was quite at the back part, where a space into which the tip of the finger could be introduced contained a little fluid blood. The inner aspect of the sawn clavicle was smooth with granulations save just at its upper part. The pleuræ were absolutely healthy. Both bases were the seat of broncho-pneumonia. The mediastinal connective tissue was extensively occupied with air: this had not penetrated beneath the pulmonary pleura, nor produced interstitial emphysema. The aortic and mitral valves, the latter especially, were diseased; the aortic arch was the seat of atheroma, dilated uniformly, irregular on the surface and rough internally, but not calcareous. The abdominal aorta was very bad, full of calcareous plates. The kidneys showed early interstitial nephritis. There was a small hard mass of clot in the innominate, below the ligature; little in the carotid. The brain was normal.

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* The notes of this case contain no mention of an autopsy.

Causes of Death after the Operation.—It may be expected that most of these will, with antiseptic precautions, disappear, viz.:

1. Suppurative cellulitis and mediastinitis.
2. Lung trouble—*e.g.*, bronchitis, pleuro-pneumonia.
3. Pericarditis.

There still remains the terrible complication of secondary hæmorrhage, which has occurred, as yet, in almost every case, and has always proved fatal, save in the case of Dr. Smyth.

Secondary hæmorrhage may occur up to the sixtieth day, as in Graefe's. It has already been discussed how far modern surgery is likely to prevent this, and certain precautions have been enumerated at p. 545. The treatment as shown is mainly preventive. When once bleeding has occurred, little can be done beyond tying the vertebral and common carotid, if this has not already been done, and plugging the wound with antiseptic gauze (iodoform or sal alembroth), and putting on pressure with shot-bags.

On the frequency of this complication the following remarks by Dr. Sabine are of interest:—

"The source of hæmorrhage and consequent failure is obvious. It came from the distal side of the ligature, and especially from the subclavian. . . . . In the majority of cases the artery is not more than 1½ inch between its origin and point of bifurcation. What, now, could be supposed to be the result of ligature of an artery so short, and at the same time situated so near two currents of blood—viz., that through the aorta, and that which would pass from the carotid into the subclavian? Fatal hæmorrhage, either from the distal or proximal side of the ligature, according to its seat. If the ligature be placed near the origin, it would be impossible for a clot to form on its proximal side, owing to the full current of blood passing through the aorta, though there *might* be one on the distal side. On the other hand, if it were placed near the point of bifurcation, though a clot would in all probability be formed on the proximal side, as happened in three of the cases already cited, and nearly in a fourth, none would be formed on the distal side, more especially in the subclavian, for in two of the cases, and nearly in three, the carotid was obliterated. . . . .

"The third place where a ligature might be placed is midway between the point of origin and that of bifurcation. In this case there would be a very great chance of neither a proximal nor a distal clot being formed. It allows only ½ to ¾ inch on either side of the ligature, a space too small to render the formation of clots at all probable in an artery as large as the innominate. It is thus seen that, in whatever situation a ligature be placed, secondary hæmorrhage will almost inevitably occur, and probably from the distal side, because a ligature could not, without very great difficulty, be applied much below the bifurcation, and hence there would be sufficient space for a proximal, but not for a distal clot."

SURGICAL INTERFERENCE IN ANEURISMS OF THE INNOMINATE AND AORTA.

In spite of the amount of work done in this direction, the question how far any surgical interference is justifiable remains unsettled. The importance of the subject, the difficulties with which it is beset, justify an allusion to it in this place, it being understood that the question of surgical treatment only arises either when a sufficient trial of medical treatment has failed, or when the time for this has gone by, and the distress of the patient justifies resort to uncertain operations in the hope of giving relief rather than of bringing about a cure.

The advisability of resorting to surgical means will be considered under the heads of—A. Diagnosis; B. Treatment, the latter including—(i.) Ligature; (ii.) Introduction of Foreign Bodies; (iii.) Galvano-puncture.

A. **Diagnosis between Innominate and Aortic Aneurisms.**—It is well known how extremely difficult this matter is; the expression of a confident opinion is, too often, quite out of the question (p. 561). While a precise diagnosis is usually impossible, no pains should be spared in going into all those points which may help in deciding how far the aneurism is probably limited to the innominate or to the aorta, and, in the case of this vessel, which piece of the arch is chiefly encroached upon, for it is only by paying attention to the above points that answers can be given to the two questions which arise—viz., (1) Is any operation justifiable at all? (2) If an operation is justifiable, what is it to be?

Chief Points to pay Attention to in Diagnosis.

1. *The Position of the Aneurism.*—This is obviously only of value in a few cases, when the patient is seen early, or when he can be relied upon for an intelligent history of his case. Mr. Wardrop's rule was, that innominate aneurism first presents itself to the inner side of the right sterno-mastoid, carotid aneurism in the interval between the two heads, and a subclavian one to the outer side of the muscle. Mr. Barwell[*] writes of the first of the above thus:—"The tumour of an innominate aneurism generally occupies the episternal notch, but chiefly on the right side, and, even though it may not rise high, takes up the whole breadth of this space. On gently pressing the finger

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[*] *Intern. Encycl. Surg.*, vol. iii. p. 507.

backward and downward, the rounded margin of the sac can be felt. After a little time the sternal end of the clavicle protrudes abnormally, and partakes in the pulsation (communicated), while the sternal and, afterwards, the clavicular portion of the sterno-mastoid are also pushed forward. Not unfrequently the first costal cartilage, outside where it joins the sternum, is also abnormally prominent, and throbs with the beat of the tumour."

Mr. Heath thus describes (*Dict. of Surg.*, vol. i. p. 81) the possible points of appearance of an aortic aneurism :—" If on the ascending portion of the arch, the sac presses against the sternum, producing gradual absorption of the wall of the chest, and communicating a marked impulse to the right side of the sternum as high as the sterno-clavicular joint, which may be invaded by the tumour in the later stages. If on the transverse portion of the arch, the sac encounters but little resistance in an upward direction, and hence is apt to invade the inter-clavicular notch, to compress the trachea and occasionally the œsophagus, and to produce marked spasm of the larynx by interference with the left recurrent laryngeal. When a sac of this kind rises into the neck, it is a matter of uncertainty to which side it should be allotted, since a tumour projecting most to the right by no means necessarily *originates* on the right side, and *vice versâ*."

2. *The Pulse*.—If a decided diminution is found in the right radial and carotid, the aneurism is probably of the innominate; but an aortic aneurism near the root of the innominate will bring about the same result.

3. *Pressure Symptoms*.—These will vary with the position as well as the size of each form of aneurism. Thus, in innominate aneurism pressure symptoms will vary according as it is high up or low down, and pressing inwards or outwards. As to œdema, the value of this must remain undecided while surgeons hold such opposite views. Thus Mr. Heath * and Mr. Erichsen† speak of œdema of the right side of the neck and upper limb as first noticed. Mr. Barwell,‡ on the other hand, speaking more particularly of the low form of innominate aneurism (usually combined with aortic disease), writes : " The point to be especially remarked is this—the pulsation, dulness, abnormally loud heart sound, &c., are on and to the *right* of the middle line ; the venous congestions are on the *left* side of the body, nor does the right participate till late in the disease. . . . . When the right side is also involved, the aneurism will have become large."

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* *Loc. supra cit.* † *Surgery*, vol. ii. p. 75. ‡ *Loc. supra cit.*

I cannot find that the other pressure symptoms—viz., laryngeal or tracheal dyspnœa, irregularity of the pupil—are really distinctive between innominate and aortic aneurism.

Mr. Barwell considers that the following combinations of symptoms "furnish remarkably positive evidence" in aortic aneurism :—"For instance, pressure wholly and entirely on the right bronchus ; congestion of both arms and both sides of the head and chest ; tumour symptoms, chiefly about the second space and rib, considerably to the right of the sternum ; heart displacement, if any, directly outward ; the pulses equal, with very slight sphygmographic change—perhaps a rather sloping upstroke, usually a blunt, flat apex, absence, partial or total, of dicrotic wave, but undulatory character of whole down-line—indicate disease of ascending aorta. Congestion of the left arm, supra-clavicular region, and side of the head ; aneurismal character of right pulse (radial and carotid) ; tumour symptoms a little to the right of the sternum, and probably some tracheal dyspnœa, are symptomatic of aorto-innominate aneurism. Modification of left radial pulse, affection of left vocal cord, left venous congestion, tracheal dyspnœa, and obstruction of air to both lungs, with tumour symptoms on and to the left of the median line, mark disease of the transverse aorta. Obstruction to the entrance of air to the left lung alone, with pains at the back and along the intercostals, is indicative of disease of the third part of the arch."

4. *Displacement of the Heart Downwards.*—The more marked this is the greater is the probability that the aneurism is aortic.

Difficulties and Fallacies in the Diagnosis.

1. The proximity of the heart. "When there is a bruit, it is extremely difficult to distinguish whether it is limited to the tumour or is propagated into it from the cardiac valves ; whether the pulsation is limited to the neck, or extends also into the thorax ; and whether one only of the large vessels is implicated, or whether others of the great arteries in the neighbourhood, or the whole trunk leading from the heart, may not be diseased and dilated."

2. "The growth of aneurisms in the cellular tissue of the mediastinum and root of the neck is so free that instances have been observed of aneurisms of the arch of the aorta causing compression of the subclavian and carotid, without any disease of those vessels ; while, on the other hand, if the aneurism approaches the tubular shape, the pulse may be unaffected in the branches, though the trunk is extensively diseased" (Holmes *).

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* *Syst. of Surg.*, vol. iii. p. 14.

3. The distribution of the branches of the aorta may be anomalous.*

The following remarks of Mr. H. Morris on a case of aortic aneurism illustrate the extreme difficulty of diagnosing here:—"No one who examined this woman questioned that the aneurism was innominate, and some very capable diagnosticians considered it to be a simple sacculated aneurism of that vessel. Even after dissection it was impossible to make out its true character until the sac had been laid freely open in front, and the innominate artery behind. The situation and outline of the tumour, the pain in the shoulder and over the right side of the head and neck, led to the diagnosis of innominate aneurism. The origin of the disease from the aorta might have been suspected if more weight had been given to the severe *gnawing* pain across the front of the *chest* suffered at the onset; to the dilated veins on the right side of the upper part of the chest; to the equality of the radial pulses; to the absence of any cough, dyspnœa, and throat dryness, of any deflection of the trachea, of any numbness or loss of power in the right arm (such frequent symptoms in innominate aneurism); and to the fact that aortic aneurism causes tumours in the neck."

B. Treatment.

I. Ligature.†

Aids in selecting Cases fitted for Operation.—Mr. Barwell (*loc. supra cit.*, p. 520) writing on innominate aneurisms, has formulated the following aphorisms:—

i. An aneurism commencing suddenly, especially if traceable to some over-exertion, is more likely to be benefited by operation than one arising gradually and without mechanical cause. ii. Distinct sacculation is a most desirable condition; fusiform dilatation of the innominate indicates almost certainly a similar condition of the aorta and widespread arterial disease. iii. If symptoms show the aortic arch to be also affected, the disease should be limited—that is, should not extend along the transverse portion. It should be of the sacculated variety, not a general dilatation of the whole calibre. Absence of any other aneurism, especially of the rest of the aorta, must be ascertained. iv. Absence of rasp-sound along the aorta, or any other indication of extensive atheroma, should be verified. v. Aortic incompetence, unless very slight, is a decided objection, as is also mitral disease, or considerable hypertrophy of the heart. vi. The patency of the vessels leading to the brain should be investigated by making a few seconds' pressure on the carotids alternately and then simultaneously. vii. Absence of visceral disease must be ascertained.

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* Mr. Holmes quotes the following instructive case:—In a patient in whom, from other symptoms, there was no difficulty in diagnosing an aneurism of the arch of the aorta, one circumstance was difficult to account for—viz., that while the pulse in the right carotid was unaffected, that in the right wrist was imperceptible. After death the right subclavian was found to be the last branch of the aorta. Passing between the aneurism and the spine it had been compressed, while the carotid was unaffected.

† Many of the remarks below apply also to the two other methods of surgical interference—introduction of foreign bodies into the sac and galvano-puncture.

Before deciding to recommend operative interference in these aneurisms, the surgeon should, I think, consider most carefully the following points, which appear to me to be the outcome of recorded cases :—

1. It is possible that too much importance has been attached to a very few successful cases, and that too little attention has been given to the fact that numerous unsuccessful cases have occurred which have never been published.

2. It is certain that, in some cases, operative treatment may not only fail to check the progress of the aneurism, but may actually and decidedly hasten the fatal issue. This grievous result may not only be brought about by the difficulties of the operation itself, but also by this special and untoward result which is common to all operative treatment here—viz., that, as in these aneurisms the contiguous part of the large vessels (aorta especially) is often extensively diseased, and as other aneurisms may be present, ligature of one vessel, by checking the flow of blood at one part, may throw the current suddenly upon another, perhaps unfit to bear the strain, or, from its relations, more likely to produce grave pressure-symptoms.*

"If the enormous difficulty of diagnosis, the great risks of the operation, the possibility of spontaneous improvement, if not of cure, and of palliation by rest and diet, and also the fatal results of recorded operations, be taken into due consideration, it seems that the distal ligature on the right side should be limited to desperate cases, and then performed only with the expectation of relief, not of cure" (Morris†).

Contra-indications to Operative Interference.—Mr. Barwell (*loc. supra cit.*, p. 528) lays down the following :—(1) When tumour symptoms reach widely on both sides of the middle line; (2) when, with paralysis of the left vocal cord, there is obstruction of the right bronchus; (3) when there is evidence of considerable aortic incompetence; (4) when there is mitral disease or considerable cardiac hypertrophy; (5) when there is, in the course of the aorta, the rasping sound of calcification or advanced atheroma, more particularly if the superficial vessels are rough and rigid; (6) when there is pain about the spine and intercostal nerves; (7) when there is obstruction of the left bronchus only; (8) when there is pressure on the left apex, and expectoration of frothy blood.

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* The rapid extension of the aneurism in another direction after its original growth has been checked by operative interference is well shown by a case of Dr. Churton's (*Clin. Soc. Trans.*, vol. xix. p. 261), in which, subsequently to galvano-puncture, the blood-pressure found out other weak spots in addition to the original aneurism, thus bringing about other saccular projections and fatal rupture into a bronchus.

† *Loc. supra cit.*, p. 103.

Choice of Vessel.—Question of Simultaneous or Consecutive Ligature.—I have no space here for quoting statistics, which are, after all, of inferior value to the authoritative opinions of those who have worked most at this subject. The earliest and foremost of these is Mr. Holmes; as it is to his opinion that English surgeons will naturally turn, the most important of his recent views are given here.

1. "One thing, I think, has been fully proved—viz., that the distinction which was so much insisted on between aortic and innominate aneurism is of less importance in regard to the distal operation than used to be taught, and that a case of innominate aneurism which otherwise seems appropriate for operation need not be rejected because it is suspected or known that the aorta is also involved. It has also been satisfactorily proved that aneurisms purely aortic have been much benefited by distal operations. It remains to inquire what cases should be selected, and what arteries should be tied in each case."

2. "To my mind the clearest evidence of benefit has been in the case of ligature of the left carotid in the treatment of aneurism affecting the transverse part of the arch." In a case of this kind it was the evident extension of the tumour up the neck and towards the trachea which made Mr. Holmes think that the ligature would prove beneficial, and the result even surpassed his expectations, the patient being alive and in tolerable health five and probably seven years after the operation. Thus Mr. Holmes, considering that the applicability of the distal ligature depends largely on the observed growth of the tumour, would think ligature of the subclavian justifiable if, in innominate or mixed aneurism, the tumour was making rapid advance under the sterno-mastoid. He also draws attention to the importance of estimating pressure-signs as indicating extension of the aneurism, as evidenced by the condition of the veins, the breathing, the pupil, &c. (p. 559).

3. With regard to operations on the right side in cases of innominate or mixed innominate and aortic aneurism, opinions vary as to whether the carotid or subclavian should be tied simultaneously, or whether the carotid should be tied first. Mr. Holmes, who holds this latter view, evidently thinks that ligature of this vessel may be sufficient without any consecutive ligature of the subclavian, unless indications arise—*e.g.*, the manifest growth of the subclavian portion of the sac, or the effect of compression of the subclavian in diminishing the size or the pulsation of the tumour.

Mr. Holmes' chief reasons for preferring ligature of the carotid alone as a first step are—(*a*) that while the number of cases of simultaneous ligature is much the larger, the most striking instances of success have followed ligature of the right carotid alone; (*b*) in some cases, where ligature of the subclavian has been also resorted to later, the aneurism was already diminishing and becoming firmer after ligature of the carotid; (*c*) the simultaneous ligature of two such vessels as the carotid and the subclavian may be a very formidable undertaking from the prolonged dissection and difficulties with the anæsthetic; (*d*) as ligature of the left carotid has proved sufficient in aortic aneurism, a similar step should be tried on the right side in innominate aneurism.*

Another interesting and unsettled question bearing on this matter of ligature of large vessels near the heart is **the most appropriate material for ligature.** This has been already discussed p. 540.

Facts which show that the resort to Ligature has been justifiable.

1. Solidification and diminution in the size of the swelling.

2. Diminution of pulsation. In one case of Mr. Barwell's (*Med. Chir. Trans.*, vol. lxviii. p. 130), a month after simultaneous ligature of both arteries for innominate aneurism, the swelling again began to increase and the solidifying tumour to soften, pulsation also recurring; this went on for about two weeks, when the swelling again solidified and decreased, recovery ultimately taking place.

3. Improvement in dyspnœa, dysphonia, and dysphagia.

4. Regain of power over a limb.

5. Expectoration of muco-purulent discharge which has been

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* Mr. Barwell (*loc. supra cit.*, p. 328) goes a good deal further as to the points which he believes will serve to guide the choice of the surgeon. Time alone will show how far these are reliable.

accumulating in the lungs owing to interference with expiration from pressure on the trachea.

II. Introduction of Foreign Bodies into the Sac.—This method was originally brought before the profession by Mr. Moore (*Med. Chir. Trans.*, vol. xlvii. p. 129), who introduced 26 yards of fine iron wire into an aortic aneurism. No relief followed, inflammation of the sac set in, and the patient died five days later.

More recently, Dr. Cayley has published a similar case in which 40 feet of wire were introduced by Mr. Hulke. Some relief was given to the pain, and some consolidation had evidently taken place, but extension followed in another direction, causing urgent tracheal dyspnœa. On this account wire was introduced a second time, 34 feet being got in. Death followed nine days later. Owing to this material being considered too irritating, it has not been much used.

Other surgeons have made use of catgut and horsehair, but with these less irritating substances the great difficulty is to get much into the sac, as they readily bend on themselves in the cannula.* In the summer of 1887, in a patient of Dr. Pye Smith's, with a large aortic aneurism coming through the chest wall, I introduced about 40 feet of horsehair by means of an ingenious method suggested to me by Dr. Perry. No good was done, the patient dying shortly after, worn out with pain. The post-mortem examination showed that the clot formed by the horsehair was too localized to have effected much in the huge cavity formed by the aneurism.

Another method, that of introducing very fine needles, is, I think, more deserving of trial. Suggested by Mr. Moore, it has been tried by Mr. Heath and Mr. Puzey.† The former made use of it in a traumatic aneurism of the subclavian, where amputation at the shoulder-joint had failed. Three pairs of sewing needles were introduced into the tumour, each pair being made to cross in the sac; they were not withdrawn until the fifth day, by which time considerable clotting had taken place. The aneurism gradually became solid; but bronchitis supervened, and the patient sank seventeen days later. Mr. Puzey followed Mr. Heath's plan in an aneurism of the innominate, but, no apparent effect taking place at the end of four or five days, other needles were inserted as the first were withdrawn, but at different parts of the swelling. This procedure being carried out for several weeks, the aneurism finally almost disappeared behind the sternal end of the clavicle. Unfortunately, the needles set up some chronic cellulitis, septicæmia followed with vomiting, and fatal rupture of the sac. Mr. Puzey thinks this case affords a warning against pushing this treatment too far, and that it would be better to wait patiently the results of the first introduction of the needles before proceeding to insert others.

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* I know of one case in which specially prepared very long pieces of catgut were introduced into an aneurism in the neck. At the post-mortem some of these were found to have passed on, beyond the aneurism, into the splenic artery. In the *Ann. of Surgery*, vol. iv., No. 2, a case of Dr. Ransohoff, of Cincinnati, is recorded, in which 96 inches of flexible silver wire were passed into an aneurism of the aortic arch. After the first 48 inches had been introduced, syncope, with impending death, set in. With the aid of stimulants, the operation was completed. For a fortnight the symptoms were improved, when œdema of face and right arm appeared; 98 inches of wire were then passed into another part of the sac. The patient died eight days later, from rupture of the aneurism. The syncope was found to have been caused by a loop of wire which had passed beyond the neck of the sac into the aorta, where it was probably deflected by the aortic valves.

† Art. "Acupuncture," *Dict. of Surg.*, vol. i. p. 25.

If the introduction of foreign bodies be resorted to, antiseptic precautions * should, as far as possible, be made use of. The following directions for the use of wire are given by Mr. Moore (*loc. supra cit.*, p. 135):—"Choose wire which is stiff enough to pass the cannula without bending, but so fine as to bend easily when pressed against the wall within the aneurism. Provide a straight short cannula of thin silver, sharply pointed at one end, expanded at the other, and let its tube be somewhat larger than is sufficient to give ready passage to the wire. Let there be also a thicker wire which fills the cannula, and is flattened at the end. This is for use as a probe. Puncture with the cannula some part of the aneurism which shall not be opposite to the presumed situation of the aperture from the artery. Introduce the probe, and ascertain the position and size of the arterial opening, as well as the dimensions of the aneurism itself. This would determine the directions in which the fine wire should be introduced and the quantity which the aneurism might be expected to hold. Push in the fine wire, directing its point against the opposite wall of the sac, and, whilst introducing more, divert the end of the cannula. The wire must bend from its fixed extremity in a curve determined by the direction given by the cannula. Continue to introduce wire and to move the cannula, and coils of wire will be formed of any required shape and in any part of the sac. In withdrawing the cannula the wire must not be suffered to remain in the puncture; if it did so, the issue would probably be fatal hæmorrhage. The last part of the wire must be pushed fairly into the aneurismal cavity with the flat end of the probe. The cannula may then be withdrawn upon the probe, on the removal of which, last of all, the skin should slip back again over the tumour, and the puncture in the sac would not correspond with that of the skin. The puncture might be covered with collodion."

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* Mr. Hulke in his case, in order to cleanse the steel wire thoroughly, &c., and thus to get rid of the risks of pyæmia, soaked it for twelve hours in strong liquor potassæ; strict antiseptic precautions were used, including the passage of the wire between carbolized sponges.

Mr. Barwell's Modification of Moore's Method. — This consists in passing 10 feet of steel wire into the sac, and sending a current through it to bring about, by electrolysis, rapid deposit of clot. The patient had a large aneurism of the aortic arch, with serious lung trouble. Ten feet of steel wire were introduced with a fine insulated trocar. To the wire the positive pole was attached, while a negative pole of spongio-piline was placed on the back. A current of 10 milliampères was passed for an hour and ten minutes, without pain. In twelve hours the tumour was more solid and the pulsation more distant. Four days later a swelling, which had been observed two years before and disappeared, reappeared in the neck, evidently a secondary sac. A week later the patient died of his lung-trouble. At the autopsy, "the wide coils of wire are surrounded with thick, firm, colourless clot, which in many places binds the wire to the sac walls, thus strengthening them and rendering rupture hardly possible." In the secondary sac this had not formed. Two cases thus treated are recorded by Dr. Abbe (*Ann. of Surg.*, vol. vi. No. 4): one died in three weeks, with threatening gangrene of one toe, perhaps embolic; in the other, on the second evening, the sac, here diagnosed as "a dissecting subclavian aneurism," ruptured into the trachea. In neither case could an autopsy be obtained.

III. GALVANO-PUNCTURE.—This method has for its object the production of clotting without the risks and difficulties connected with the introduction of foreign bodies. Like the latter, it has scarcely had a fair trial, being too often not made use of till the size attained by the aneurism forbids any hope of cure, and almost of relief.

Points to pay attention to.—(1) To avoid production of heat, pain, and sloughing of the skin, the current* used should be a comparatively weak one. As an anæsthetic is not usually required, the time occupied may be considerable. (2) The needles should be of steel, as fine as is consistent with perforating the tissues, in order to diminish pain, hæmorrhage, and risk of sloughing.* (3) To avoid the same risks, the needles should be insulated within about ½ inch of their points by two layers of spirit varnish. (4) As it has been proved that the effect of electrolysis on blood at the positive pole is a fairly firm and tenacious dark clot, while the negative rather produces a pinkish frothy substance, it seems wiser to connect the needle or needles introduced into the sac with the positive pole, while a large sponge wrung out of warm salt-water is connected with the negative pole and applied to the chest wall near the swelling. (5) A sitting should not be prolonged over thirty or forty minutes. The punctures had best be closed by collodion. (6) The operation should not be repeated too soon, time being allowed for all local reaction to cease and for consolidation of the coagulum to occur, which often takes some time.

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* Dr. McCall Anderson, in a most successful case (*Lancet*, 1873, vol. i. p. 261), employed four to six cells of a Stöhrer's battery. In a case of Dr. Ord (*Lancet*, 1880, vol. ii. p. 450), followed by temporary benefit, six to eighteen cells of a

Drawbacks and Dangers.—(1) As pointed out by Mr. Holmes, "it is a radical defect of this method that it acts by inducing 'passive' coagulation of blood in the sac. Hence, it is inherently uncertain, liable to cause relapse by the melting of the coagulum, or inflammation by its too sudden deposition. Again, it is very liable to set up inflammation in the walls and contents of the sac. Then, too, the needles sometimes produce eschars at the points of their insertion, and thus give rise to consecutive hæmorrhage. In fact, the cases are few in which a perfectly happy result has been obtained, but some of these are worthy of particular attention.

Amongst these is a case of Ciniselli (Holmes, *loc. supra cit.*), in which an aneurism of the ascending aorta, quickly increasing, pushing out the third and fourth ribs, with powerful pulsation, rapidly diminished with much solidification after galvano-puncture for forty minutes, the patient resuming his work as a coachman ten weeks later. In Dr. McCall Anderson's case the aneurism was a small one, about 3½ inches in diameter; after galvano-puncture on three occasions, the swelling was only about one quarter of its previous size, and for the most part very solid. In a case of Dr. Carter's (*Lancet*, 1878, vol. ii. p. 761), an aneurism

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Foveaux's battery were used. Dr. Bastian (*Brit. Med. Journ.*, 1873, vol. ii. p. 595) made use of five to eleven cells of the same battery.

[*] With this object, Dr. Bastian used a small hare-lip pin. Dr. Duncan's needles, as made by Weiss, seem very large.

of the thoracic aorta appearing in the right sub-clavicular region, and accompanied by much pain, was treated by galvano-puncture on three occasions with very great relief, the pulsation becoming almost imperceptible and the pain disappearing.

In deciding between the introduction of foreign bodies (*e.g.*, wire) and the use of galvano-puncture, I think (1) that the use of needles (p. 565) deserves a further trial; (2) that if galvano-puncture has given better results than wire or catgut, this is due to too large amounts of these foreign bodies having been introduced.* Even when some material is found less irritating than wire and not so flexible as catgut or horsehair, and therefore more manageable, galvano-puncture will, probably, still be safer and more resorted to.

It is clear, however, that, if anything like prolonged relief is to be given, such operations must be resorted to at an earlier date than has hitherto been the case, and I would again draw attention to the remarks at p. 562 (a point to which attention has not been sufficiently directed), that surgical interference may, in cases of large aneurism, do more harm than good by diverting the blood-current from the original aneurism into some outlying and unsuspected secondary sac, and thus causing pressure on important parts which have hitherto escaped. Besides this danger, three others have to be remembered when wire is introduced. (1) Embolism. (2) Suppuration of the sac. Both these have been made much rarer by carefully rendering the wire aseptic. Any inflammation of the sac should at once be treated by ice-bags. (3) Introduction of the wire beyond the aneurism (foot-note, p. 565).

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* In two cases in which wire was introduced into the sac of an abdominal aneurism by the late Prof. Loreta, great relief followed.

PART III.

OPERATIONS ON THE THORAX.

CHAPTER I.

REMOVAL OF THE BREAST (Figs. 104, 105).

Indications.—The following remarks must be considered to refer to that most common and important of diseases—carcinoma.

As recurrence after operation is, sooner or later, practically certain in the great majority of cases—"as certain as anything in surgery" (Paget)—**a careful and judicious selection of cases** is of the utmost importance. For such a purpose cases of carcinoma of the breast fall into the three following groups:—

A. *Cases to which an Operation is altogether unsuited, or especially doubtful and (in many) dangerous.*—(1) The very aged, *e.g.*, after sixty; not only are the aged less healthy, but they are less troubled by the cancer, and more resigned. (2) The unhealthily fat * and plethoric. (3) Habitual over-eaters. (4) Tipplers on the sly. (5) The subjects of a confirmed bronchitis, and weak heart. (6) Subjects of decided albuminuria, cirrhosis, or diabetes. (7) Extensive disease of the skin, accompanied by scattered tubercles or œdema, and, worst of all, a brawny, leather-like, greasy condition of the skin, with firm œdema and open sebaceous glands, approaching the condition of cancer *en cuirasse*. (8) Quick growth, with rapidly increasing fixity.* (9) Supra-clavicular disease.† (10) A young patient, especially with a voluminous breast,‡ a rapidly increasing growth, and a bad family history. (11) Of course, the presence of carcinoma elsewhere—*e.g.*, uterus—or secondary deposits. That operation is not absolutely contra-indicated where both breasts are involved is shown by a case of Mr. Page's (*Brit. Med. Journ.*, 1888, vol. ii. p. 937), in which both breasts were the seat of carcinoma, and both were simultaneously operated on by Mr. Page and Mr. Silcock. The patient, aged sixty-eight, made a good recovery. Notes are also given of another interesting case, in which a large carcinomatous breast was successfully removed, an axillary gland being also removed, in a woman aged seventy-four.

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* Sir James Paget, from whom several of the above have been taken, thus writes (*Clin. Lects. and Essays*, p. 14):—"The over-fat are certainly a bad class, especially when their fatness is not hereditary, but may be referred in any degree to their over-eating, soaking, indolence, and defective excretions. The worst of this class are such as have soft, loose, flabby, and yellow fat, and I think you may know them by their bellies being pendulous and more prominent than even their thick subcutaneous fat accounts for, for this shape tells of thick omental fat and, I suppose, of defective portal circulation." Some earlier remarks of Sir James may here be quoted: "Such people must be carefully managed; not fed too well; not kept too long in bed; not allowed to retain their refuse; and mere bigness must not be taken for plethora."

B. *Cases in which an Operation is indicated.*—(1) Cases somewhat advanced in life, for the younger the patient the more active is the cancer. (2) Especially if patients who are on in years are thin and dry and tough, clear-voiced and bright-eyed, with good pulses and digestion, and no cough or wheezing. (3) Small breasts and little fat. (4) Where the growth is circumscribed with distinct outline. The worst defined tumours are the worst for recurrence. (5) Where the growth is very hard. The "stoniest" growths are usually the slowest. (6) Skin not involved. (7) Absence of fixity. (8) Either no axillary glands, or but very few, involved. (9) Rate of progress slow, and family history good.

C. *Cases in which an Operation is doubtful.*—These lie intermediate between A and B, both as to general and local points.

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* There are no worse cases for operation than those in which malignant disease supervenes on mammary abscess and induration in suckling women.

† If other points are favourable, and if it seems justifiable on account of pain, threatening ulceration, &c., to give the patient temporary relief by the removal of the breast, enlargement of glands here need not deter the surgeon; when the disease has been removed below from the breast and the axilla, the supra-clavicular glands will, I believe, be found to enlarge slowly, and as the space which contains them is large, they do not become adherent quickly. I have twice within the last four years operated in cases in which these glands were slightly involved. In one the patient lived three years, in the other fourteen months, after the operation.

‡ The larger and the more vascular the breast, and the more abundant the fat, the more difficult will it be to make certain of extirpating not only the growth, but also every atom of the breast. While speaking of vascularity, I am reminded that I have been asked if removal of the breast is justifiable in the subjects of hæmophilia. The only case bearing on this that I am acquainted with is one recorded by Mr. Macnamara (*Lancet*, 1884, vol. i. p. 294). The patient here had had epistaxis, from which four relatives had died. There was no history of bleeding from wounds. The breast was removed with a loss of blood "certainly not greater than is usual in such cases."

Questions which the Surgeon may be asked, or which he may have to put to himself.

1. *How long will my patient live if I do not operate?* This can only be answered approximately by considering the *average* duration of life, from the earliest discovery, in cases of scirrhus. This is about two years and a half.*

2. *How long will she live if I do operate?* If the discovery and the operation are early ones, three years and a half may be hoped for, in cases operated on, from the first discovery to the close. Mr. Sibley (*loc. supra cit.*) gives fifty-three months; Mr. M. Baker fifty-five months.

3. *What is the average date of recurrence after operation?* About a year. Mr. Sibley gives (*loc. supra cit.*) fourteen, Mr. M. Baker thirteen, months. If anything, the above averages are probably too favourable: while the extremes vary from two months to ten years, more than half return within twelve months; about two-fifths return in six months. I have left the above unaltered in this edition, but it is obvious that the far more thorough operations of the present day will necessitate revision of these dates.

4. *What are the risks of the operation itself?* In other words, what are the risks that the patient, instead of dying in one or two years of the disease, may die in one or two weeks of the operation?† In most cases, with careful after-treatment on modern lines, the risks are slight. The deaths from operation are mainly due—(*a*) to septic causes—*e.g.*, erysipelas, pyæmia, &c.; (*b*) to lung-trouble—*e.g.*, broncho-pneumonia; (*c*) to the anæsthetic in a patient the subject of old bronchitis.

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* Mr. Sibley (*Med. Chir. Trans.*, vol. xlii.) gives thirty-two months; Mr. M. Baker (*ibid.*, vol. xliii.) gives forty-three months. Mr. Beck (*Dict. of Surg.*, vol. i. p. 185), apparently quoting from Prof. Gross, divides the course of an ordinary scirrhus of the breast, unrelieved by treatment, into these three stages:—*First*, when the disease is limited to the breast, the duration of this first stage averaging fourteen months. *Secondly*, the stage of the skin and the axillary lymphatics, taking, in the average, from the fourteenth to the twentieth month. *Thirdly*, the stage of ulceration and general infection, usually taking from the twentieth to the twenty-seventh month to close the case in death. In atrophic scirrhus the average duration of cases not operated on is given as eighty-two months, patients having been known to survive fifteen or even twenty years. With encephaloid cancer the average duration is under a year. Even after removal of the breast it is said to be only sixteen months and a half.

† Sir James Paget and Mr. Erichsen gave 10 per cent.; Mr. Bryant, 6 per cent.; Dr. Stettegart, giving the statistics of operations performed from 1873 to 1876 in one of the hospitals at Berlin, gives a mortality of 7 per cent. where the breast alone was removed, and 23 per cent. where the breast was removed and

Fresh statistics, to be of any value, will be required of this operation, performed with modern completeness, and with strict aseptic precautions maintained throughout.

Reasons which may make a Patient wish for an Operation beyond gaining a mere Prolongation of Life.—These may be: (*a*) Relief from pain,[*] which otherwise increases daily; the misery of waking every day to the consciousness of an incurable disease;[†] the sometime loathsomeness; the restlessness for cure (Paget). (*b*) The return of the disease in the scar is often less grievous than the original disease—*i.e.*, the induration, ulceration, excavation are slower and less marked than in the breast-tissue.[‡] (*c*) Death by deposits in the viscera, these being unseen, is less distressing to the patient than death by the original cancer in the breast, which s always under her eyes. (*d*) The patient may

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the axilla cleared out as well (Lang. *Arch.*, Bd. xxiv. 1879). These statistics, nowadays, require revision. Thus, Mr. Butlin (*loc. infra cit.*, p. 370) considers that the mortality should not exceed 5 per cent.

[*] The uncertainty of the pain attendant on cancer of the breast is well known. Almost always absent for the first year or more, save when the bosom is handled, pain may scarcely be present from first to last. More frequently after the above dates the pain becomes increasingly dull and heavy, then more and more lancinating; finally, when the growth is ulcerating, a hot burning sensation is substituted for, or added to, the lancinating pain (Paget, *Surg. Path.*, pp. 646, 647). Thus, while the growth is small and can be removed with good hope, the patient refuses operation because she cannot believe in cancer without pain. Later on, when she seeks relief from her pain, all hope of giving permanent relief has usually passed away.

[†] Sir C. Bell's vivid picture of the advanced stage of cancer of the breast may be quoted here. It should stir up in every mind an earnest desire to secure earlier operations. "The general condition of the patient is pitiable. Suffering much bodily, and everything most frightful present to the imagination, a continual hectic preys upon her, which is shown in increasing emaciation. The countenance is pale and anxious, with a slight leaden hue; the features have become pinched, the lips and nostrils slightly livid; the pulse is frequent; the pains are severe. In the hard tumours the pain is stinging or sharp; in the exposed surface it is burning and sore. Pains, like those of rheumatism, extend over the body, especially to the back and lower part of the spine; the hips and shoulders are subject to these pains. Successively the glands of the axilla and those above the clavicle become diseased. Severe pains shoot down the arm of the affected side. It swells to an alarming degree and becomes immovable. At length there is nausea and weakness of digestion; a tickling cough distresses her; severe stitches strike through the side; the pulse becomes rapid and fluttering, the surface cadaverous, the breathing anxious, and so she sinks" (*Med. Chir. Trans.*, vol. xii. p. 223).

[‡] While this is correct, local recurrence, as being constantly visible to, and dwelt on by, the patient, is much to be deprecated. If only it was more the custom to operate very widely and deeply, and without attempting much primary union in cases at all advanced (p. 575), local recurrence would be almost unknown.

have especial reasons for wishing to live and get about in comparative comfort for a year or so.*

Operation (Figs. 104, 105).—The **chief objects** to be borne in mind throughout the operation are—

1. **To get away every atom of the disease.**—The main difficulties in securing this are—(*a*) The fact that while cancer may be actually declared in the tumour only, yet the whole breast is in a pre-cancerous condition, and one on which cancer may easily supervene if an atom of the gland is left behind. (*b*) Owing to the amount of fat which is often present, it is very difficult to make sure that every particle of gland-tissue has been removed, especially when the parts are obscured with blood.

2. **To remove entirely the lymphatic tract between the breast and the axilla.**

3. **To clear out the axilla.**—This should be done as a regular thing in every case of cancer of the breast, whether any glands can be felt or no.

†The parts having been well cleansed, including the axilla, and this space shaved, the patient's neck and abdomen well protected with mackintoshes, with warm towels beneath, the arm is carried away from the side and an elliptical incision is made from a point close to the sternum, passing along the lower border of the breast, and then somewhat upwards towards the axilla. An assistant standing opposite to the surgeon now draws up the breast, while the surgeon, taking the edge of the cut skin with his left finger and thumb, dissects this off in a downward direction till he is well below the lower limit of the breast.‡ Spencer Wells' forceps being applied to any spouting vessels, an assistant makes sponge-pressure

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* Thus, in a case mentioned by Sir B. Brodie (*Lect. on Path. and Surg.*, p. 202), he declined at first to operate on a lady with a scirrhus of the breast on the point of ulcerating. In a few weeks the patient returned, begging to have the breast removed, that, her life being rendered more comfortable and active, she might accompany in society an only daughter. The operation was successfully performed, and at the end of two years the patient died of secondary pleuritic effusion.

† Important points in the preliminary treatment are regulating the patient's diet, getting rid of her refuse, and treating any bronchitis, however slight this may appear to be. Sir W. Savory (*Brit. Med. Journ.*, 1883, vol. ii. p. 167) has advised the use of an ice-bag for five hours before the operation to diminish the loss of blood. Two cases given here show that pregnancy of three and seven months is no bar to serious operations on the breast.

‡ While the surgeon must get beyond the breast so as to make sure of removing all of it, he should not carry his knife farther down than is needful; otherwise discharges will pocket here, and may travel backwards around the ribs, pointing at the angle of the scapula (p. 578).

on this flap, and draws the breast somewhat down, while the surgeon makes another elliptical incision, starting from the same point as the first, but passing upwards along the upper limit of the breast, and then descending somewhat to meet its fellow just below the tendon of insertion of the pectoralis major.* While the breast is drawn downwards by the assistant who is making pressure on the lower flap to prevent bleeding, the surgeon raises an upper flap in the same way as the lower, taking care to get above the upper limit of the breast, and in either case keeping the point of the knife towards the skin and not towards the breast, but not sufficiently so to make "button holes."

Opportunity may be taken here to refer to these elliptical incisions, and the flaps which are raised thereby. I am strongly of opinion that the way in which they are often planned and carried out is not only futile, but highly perilous. What is far too often done, is, by means of such elliptical incisions, to include the nipple and a very slight margin of skin on either side. The breast is then quickly removed without any due precaution as to getting above and below its limits; the wound comes, without any trouble, excellently together; nothing could look better at the time, but in a few months the disease inevitably reappears. I believe that we should do much better in these days of antiseptic surgery and skin-grafting if we reverted to the ancient method of deliberately sweeping away the whole breast and all the skin over it. If elliptical incisions are used, they should be carried very wide of the nipple, close to the lower and upper limits of the breast, and the flaps should be reflected well beyond the breast limits. No skin that is even doubtful should be hesitated over for a moment. In cases of any standing, all the skin over that half of the breast, in which the cancer is, had better go. It may be answered to this that there will be a wound left, gaping more or less widely. This objection can be met, to a large extent, by following the steps detailed below. But if a gaping wound has, after all, to be left, while it does not look so well at the time, it will give a far better result afterwards.

The incisions having been made as directed, widely separated from each other, the flaps cleared off till the limits of the breast above and below and at the sternal and axillary ends are clearly defined, all freely bleeding points secured, the surgeon proceeds (Fig. 104), with his finger or the handle of the scalpel, to strip the breast from off the cellular layer which unites it to the pectoral muscle. Two precautions should be taken here :—(1) to define the lower border of the muscle, otherwise it is very easy to strip up some of the fibres of this muscle also as well as the breast over it; (2) to remember that when, as is often the case, this muscle is soft and probably fatty, it is very easy to detach some of the fibres even when the breast is not adherent to the muscle. If it be found, especially in a case of any duration, that the cancer has involved any part of the muscle, the sternal fasciculi should be cleanly removed from their bony attachments, cutting across them at these points, and stripping them up cleanly with a director: any muscular vessels which need it are now tied. The axillary border of the muscle and its fascia should be removed in most cases, as here run the lymphatics to the axilla.

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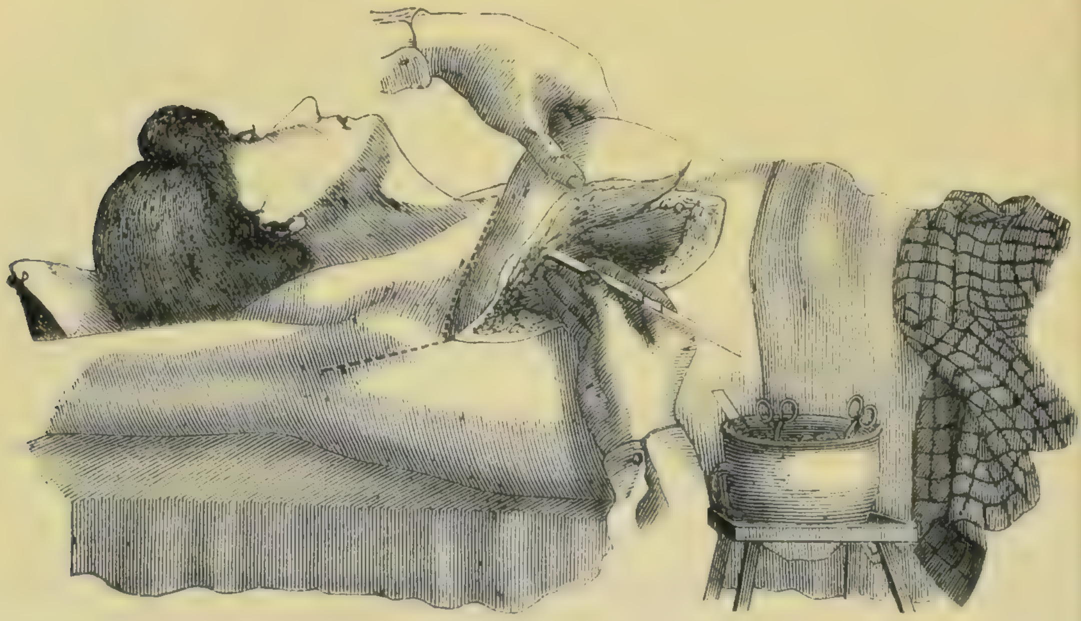
* A not uncommon mistake in marking out the flaps is to go dangerously near on one side, and then very far on the other.

FIG. 104



The breast being removed, any remaining bleeding points should be secured, and it may be here said, once for all, that, in removal of a breast, vessels will be met with chiefly at the four following points :—(1) In the cut edges of skin: (2) coming through the pectoralis major; (3) at the outer edge of the pectoralis major, coming through the serratus magnus; (4) at the axillary end of the incision, branches from the external mammary and subscapular, this latter being usually the largest of all.

Irrigation with hot mercury perchloride solution should be employed throughout, and, the wound left by the removal of the breast being covered over with sponges or lint wrung out of the same solution and often renewed, the surgeon should in every case of cancerous breast prolong his incision into the axilla along the lower border of the pectoralis major, and thence through the skin up to the biceps, so as to expose the cavity freely. A few light touches of the knife open the deep fascia, and the tip of the finger then loosens the glands and further explores the cavity. During this stage the arm is drawn more and more above the patient's head, so as to open out the axilla.

Not only every gland that can be felt or seen should be removed, but also every atom of fat that can be got out of the axilla. In this substance lie lymphatic glands, which otherwise will be surely left behind, and by its removal a source of tedious suppuration, which is always liable to follow on disturbance of fat, will be avoided.

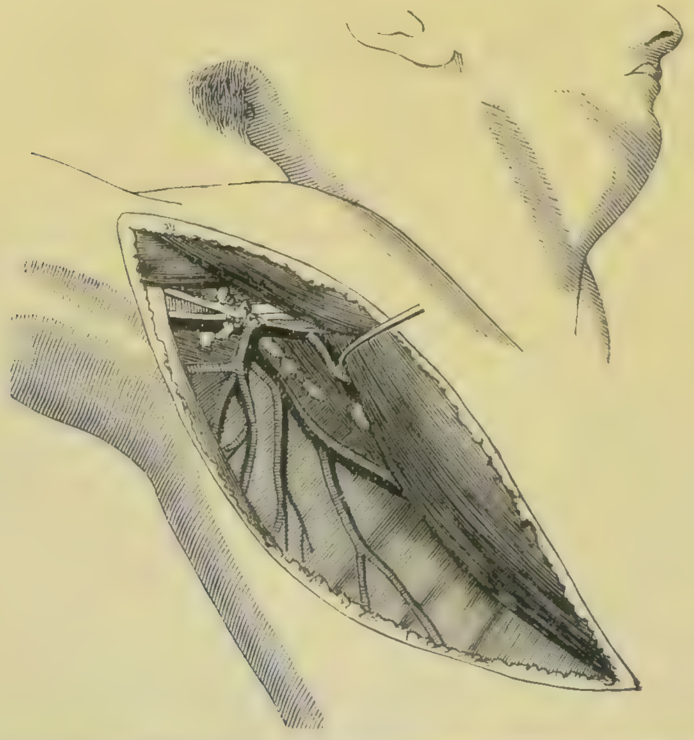
In removing the fat and glands after loosening them and freeing them with the finger, steel director, or blunt dissector, everything which feels like a pedicle, everything which does not shell away quickly, should be divided, below a pair of Spencer Wells' forceps, and the upper end tied, or secured, if preferred, with double chromic-gut ligatures passed with an aneurism needle.

Every precaution must be taken not to rupture the axillary vein, an accident best avoided by remembering its position, by using no sharp instrument, and working without any undue tearing or force. The large sub-scapular vein nearly always requires ligature, and if this, or any other branch, is torn away close to the axillary vein, an accident which here, as in branches of the internal jugular, is not at all unlikely to happen if undue force is used, or if the parts are made adherent by growth, most embarrassing hæmorrhage will take place. This is only to be met by taking up the aperture with a ligature around it, if this be feasible, or by ligaturing the vein above and below. In some cases it is not till the surgeon has reached the very top of the axilla, that he finds, his operation being well-nigh completed, that there are still glands so adherent to the vein that they cannot be removed, and that his operation must be an incomplete one.

When the axilla seems to be thoroughly cleared out, attention must still be paid to the following points :—(*a*) The edges of the pectoralis major and minor, as glands are met with here between the two muscles (Fig. 105); (*b*) the under surface of the pectorals; (*c*) the apex of the axilla. To reach enlarged glands in either of these two latter situations, both pectorals must be divided near their insertions, completely if necessary. Such a step will cause additional hæmorrhage, probably from the long thoracic and muscular branches, and will call for thorough drainage and greater attention still to keeping the wound sweet. It is, however, far better to face these than to run the risks, inevitable otherwise, of leaving mischief behind which the surgeon will never again have so favourable a chance of attacking, or of doing harm to the large vessels, by working in the dark.

If at any stage of cleaning out the axilla the axillary vein is so embedded in the malignant deposit that this cannot be removed without taking away a part of the vein also, this may be done without hesitation, two chromic-gut ligatures being first applied.*

FIG. 105.



To show the position of the chief glands and vessels in the axilla. (After Sédillot.)

The wound is now thoroughly sponged out, all hæmorrhage finally arrested, and due drainage provided for. In doing this it is often advisable not only to pass a drainage-tube from end to end of the wound, but also to puncture the lower flap, if this is large, near its attached border, and to bring out here another drainage-tube, with one end in the axilla, otherwise tension, and burrowing of discharges, which may travel round to the back along the ribs, requiring fresh administration of anæsthetics and free openings, are very likely to occur.

Due drainage being provided for, the wound most scrupulously dried, and a little iodoform dusted on it, the surgeon sees how far he will be able to close the wound. And without describing an easy case, I would say at once that it is often possible, by paying attention to the following details, when the arm is brought down, to unite a wound, perhaps completely, in which any attempt to close the edges appears at first quite hopeless, as in cases where $5\frac{1}{2}$ inches separates the flaps. To begin with, a very large number of sutures should be used, upwards of twenty-four perhaps in a widely gaping wound, so that the tension shall be distributed as evenly as possible over a large number instead of falling heavily upon a few.* Thus about eighteen or more sutures of stout carbolized silk or wire (the latter having the advantage of being rapidly twisted up) are passed some distance from the edges of the flaps near where these join the chest. This gives the sutures a firm hold, and also obliterates the extensive wound. These sutures being tightened up, the edges of the wound are brought into exact apposition with numerous fishing-gut sutures. If the surgeon is unable to unite the wound completely, he must rest content with bringing the edges of the flaps as near as may be, thinking only of extirpating the disease thoroughly, and not of the look of the wound. The stout sutures should be cut usually on the second or third day after the operation. All of them should not be divided at once, and, with regard to these and other sutures, it is not necessary to disturb the wound by *removing* the sutures. Judicious *cutting* of those on which the tension is too great is all that is required at first. Owing to the great elasticity of the skin, aided by a little morphia, I find very little pain follows a wound which is at first extremely tense.

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* In two cases in which I was compelled to remove a portion of the axillary vein between two ligatures, the resulting œdema and trouble were much less than I expected; in one case they could scarcely be said to occur at all.

The wound being finally cleansed, the drainage-tubes syringed through to free them of clots, a little iodoform is dusted into the axilla, strips of gauze, and then a piece of appropriate size and thickness, are laid over the wound, the arm and forearm brought across the chest, and a large gauze dressing thus applied. A large square piece has a hole cut in it near the upper left or right corner according to the breast removed; the arm and forearm being brought comfortably across the chest, the hand is passed through the hole, which is next slid over the limb till it is well up in the axilla, the hole being sufficiently far from this side of the dressing to allow the gauze to reach well into the scapular region. The dressings are then kept *in situ* by bandaging round the abdomen and chest, and over the clavicle and point of the shoulder, the object being to distribute the discharges as evenly as possible, and to meet their tendency to come through at three spots—viz., at the lower border of the dressings, at the sternal end of the drainage-tube, and behind the axilla. It is well, before the arm and forearm are shut in, to dust on a little zinc-and-starch powder over the elbow and palm, especially when the weather is hot and the skin delicate, owing to the irritation of the perspiration which is thus shut in.

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* Sir J. Lister's button sutures may be used, the object of these being to relax the parts, the strain being, by the leaden discs, distributed over a considerable surface, and the risk of the sutures cutting out too soon diminished. Oval discs of lead are needed from 1 inch to $1\frac{1}{2}$ inch long, perforated in the centre, and having the two sides turned up in the form of projecting wings. They are applied as follows :—The free end of a stout piece of wire is passed through the hole in a button, and secured by twisting it round the wings; the other end of the wire is then threaded on a needle, which is made to enter and emerge an inch or more above and below the margin of the wound ; the wire is then threaded through the hole in a second button, and when two or three such pairs of buttons are in place, each pair is pressed firmly against the flaps by an assistant, while the surgeon twists the wire round the wings of the second button so as to keep the stitch securely in position.

I prefer to keep my patients as much propped up as possible, and turned on to the sound side, thus facilitating drainage from, and early closing of the axillary end of, the wound where cellular tissue has been much opened up. If feasible, they should sit up with a bed-rest on the second day, and be got out of bed as soon as possible.

Question of the Need of Removal of the Whole Breast, and of Clearing out the Axilla in Every Case of Cancer.—It will be gathered from the above account that I here follow, and would advise others to follow, Mr. Banks, whose views on this matter have been so clearly and vigorously put forward.*

It is only right to remind my readers that these views have been lately criticized with much ability by Mr. Butlin (*Oper. Surg. of Mal. Dis.*, p. 375 *et seq.*). While I am well aware of the weight that is due to his opinion as that of a very high authority on malignant disease, the following are my reasons for differing from him :—

Mr. Banks holds most strongly that in every case of cancer of the breast—(1) The whole breast, the skin over it, the fascia over the pectoral muscle, and (if at all suspicious) the fibres of this muscle should be removed. (2) The axilla should be cleaned out whether any enlarged glands can be felt or no.

Mr. Butlin (*loc. supra cit.*, p. 375) considers that (A) the practice of removing the whole breast is "theoretically and practically wrong," and again (p. 375), he believes this wholesale method of treating cancer of the breast "to be unscientific and needlessly cruel to many women." Amongst his reasons, put forward with much ability and carefulness, for preferring a more partial operation are—

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* *Brit. Med. Journ.*, 1882, vol. ii. p. 1138; address before the Harveian Society (*ibid.*, 1887, vol. i.); *Liverp. Med. Chir. Journ.*, 1883.

1. With regard to recurrence. "Certainly, in the vast majority of instances, there is nothing to lead one to believe that the new growth arises in the outlying lobules of the mammary gland, or in any remains of the parenchyma of the gland." If this view be correct, it must be allowed that extensive operations with a view of removing all the breast are needless, and deserve Mr. Butlin's condemnation quoted above. But with our ignorance as to how exactly cancer recurs in the breast, can it be said to be correct? I venture, with all respect, to hold a totally different opinion on this most cardinal point. I hold with Dr. Creighton (*Contrib. to the Physiol. and Pathol. of the Breast*), that, in the great majority of cases, cancer here is a disease of a breast becoming obsolete, or actually so; that one result of this is that the atrophying acini become so disordered as to allow their epithelium to escape into, and infect, the surrounding connective tissue. Though the exact way in which this disbandment of the epithelium is started is unknown, it is a most important step, the connective tissue of people after middle life being unable to resist the encroachments of epithelium, as we see in the lip and penis. It is this which not only may start a carcinoma, but which makes it so difficult to prevent its recurrence, unless by early and complete operations, because the connective tissue goes widely beyond the breast.

On this account, believing that the whole breast is, in the great majority of cases, in a condition to become carcinomatous, and that thus partial operations are liable (especially when the coarse fat, which is often so abundant, and the hæmorrhage in the operations are remembered) to leave behind potential foci of disease, I consider that more wholesale operations are, in these days of modern surgery, the reverse of "unscientific and needlessly cruel to many women."*

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* Sir Spencer Wells, "Morton Lecture on Cancer and Cancerous Diseases" (*Brit. Med. Journ.*, 1888, vol. ii. p. 1204), advised removal of the entire breast save in a certain class of case where growths are found at the axillary border of one or both breasts. These growths may be neither of the breast nor of the axilla, but dependent upon peculiar sweat glands met with in this region. Mr. Marshall in his Morton Lecture (*Lancet*, 1889, vol. ii. p. 1048) also advocates thorough

2. **With regard to the severity.** There can be no doubt that the more extensive operations are the more severe. I doubt, however, very strongly whether, at the present day, with earlier operations, a wise selection and preparation of cases, with the antiseptic precautions at our command, aided by subsequent skin-grafting, the mortality will be largely increased. If there must be an increase, the gravity of the disease for which the risk is run, and the object that is in view, must not be forgotten.

3. **The mutilation.** All will agree with Mr. Butlin when he writes, p. 382, "I believe it affects women much more than we, and even they, perhaps, are inclined to admit, and it is not improbably one amongst several causes which lead them to conceal the presence of a tumour of the breast until long after the period at which it may hopefully be removed." While this is a matter which must be sorrowfully remembered, and its explanation weighed with due reverence when a surgeon is inclined to blame his patient for having concealed her disease, I think that another and more potent reason usually leads women to defer the operation until the setting in of the second stage and the commencement of pain, and that is, the widespread knowledge of the frequency of cancer here, and the failure of operations to exterminate the disease.* If only we could show better results—and, though not a believer in any extensive curing of cancer, I believe that we can do so by combining earlier operations, a wise selection of cases, going very wide of the disease, and paying strict attention to antiseptics throughout—women would, I think, come forward more readily for treatment with that calm good sense in which, in addition to quiet patience, they too often surpass us.

(B) **That the axilla should be cleared out in every case.**—I advocate this for two reasons :—(*a*) While I am aware that in some cases of cancer of the breast the glands are never implicated at all, while the disease recurs inveterately in the scar made for the removal of the breast, I believe strongly that, in the great majority of cases, to clear out the axilla is the wiser course, for if the surgeon wait, as Mr. Butlin (p. 383) advises, till the glands are obviously enlarged, or till there is fulness not amounting to

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measures. "Do not care about a scar, but sweep away to a great distance; follow the tissues up specially towards the axilla, especially when the tumour is on the axillary side of the mammary gland."

[*] General practitioners who see these cases in the first instance might render valuable aid here. Too many are inclined to palliate from a mistaken kindness in "hoping for the best," and many from an unbelief in the curability of cancer.

actual proof of enlargement, he will often wait till it is too late —*i.e.*, till not only the glands, but the connective tissue and fat of the axilla, are implicated as well, and till the supra-clavicular glands have had time to become infected, though not visibly enlarged. (*b*) I do not consider, with the surgery of the present day, that opening up the axilla adds to the severity of the operation. If good drainage and those antiseptic precautions which have been so often mentioned are duly attended to, the axillary wound heals rapidly.

In support of what I thus wrote in the first edition, I would call attention to the following words of Mr. Hutchinson (*Arch. of Surg.*, vol. i. No. 2, p. 125):—"A patient in whom the axillary glands as well as the breast have been removed has certainly a double chance of remaining well. I have for long, myself, adopted the plan of always removing the glands when they can be felt. But I have only recently adopted the excellent recommendation of Kocher,* that, in all cases of removal of the breast for cancer, the axilla should be cleared, whether the glands can be felt or not. It is a recommendation which is, I feel sure, based on common-sense and sound pathology. And it will be, I cannot doubt, the means of greatly increasing the average prolongation of life after these operations."

Thomas's Method of removal of Innocent Mammary Tumours.—As fibro-adenomata are far from uncommon, and as any scar on the breast is much deprecated by young women, this operation, which Dr. Gaillard Thomas, of New York, introduced in 1882, deserves a more extensive trial than it has received in this country. An incision is made exactly following the groove between the skin of the lower half of the breast and that of the chest. On reaching the muscles, the breast is dissected from them sufficiently to allow of its being turned upwards so as to expose its posterior aspect. A straight cut is then made through this over the tumour, and the latter removed. The gland is then replaced. Antiseptic precautions must be employed and adequate drainage provided. The scar is invisible save when a free incision has to be made—*e.g.*, for a fibro-adenoma high up in the breast; the ends of it then show.

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* I have been unable to find any paper by Kocher on this subject. Prof. Küster (*Surg. Congress Berlin*, 1883) strongly advocated this step, and claimed to have cured 26 per cent. of his cases, reckoning as cures all cases in which there was no recurrence three years after the operation.

CHAPTER II.

PARACENTESIS AND INCISION OF THE CHEST. RESECTION OF RIBS.

PARACENTESIS AND INCISION OF THE CHEST.

INDICATIONS for interference in pleuritic effusions. Before interfering operatively, the surgeon has two points to consider. I. **Whether fluid is present.** II. **Whether it is purulent or not.** My space will only allow of my dealing with the second of these points.

II. **Is the fluid purulent or not?** The importance of clearing up this point is manifest from the fact that if pus is present it is very rarely absorbed; it may burst into the lung, may burrow about, making its way externally, causing hectic, caries, and lardaceous disease.

A. Exploratory puncture (*vide supra*). A large hypodermic syringe and needle should be used, absolutely clean, pervious, and the needle sufficiently long and not too flexible. The timely use of this may save a patient from being treated for weeks or longer for chronic pneumonia. A grooved needle should never be trusted to. It is readily plugged by a pellet of fat, and thick pus will not flow along it.

B. Presence of pyrexia and hectic. This is not always reliable. Fallacies: (*a*) They may be absent, or little marked, in empyema, especially in long-standing cases, the alteration of the pleura or the degree of tension preventing absorption. Occasionally the disease is latent for many months. (*b*) Well-marked pyrexia may be present in serous effusions; thus, in these, the evening temperature may reach 101°.*

C. The aspect of the patient. The tint is often anæmic and earthy in long-standing empyema, and the finger-ends, especially in children, clubbed.†

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* In 1886 I tapped the chest of one of our students, under the care of Dr. Pye Smith, whose temperature was 103°. The fluid was serous, and after the single aspiration a good recovery took place.

† "If a child be seen with general pallor and finger-clubbing, one ought to

D. Age. Empyema is common in children* and young adults.

E. Rigors. These are often slight, irregular, and may occur only towards evening. In children they are often absent throughout.

F. Any preceding disease. Empyema is not unfrequent after pneumonia, scarlet fever, measles, childbirth, pyæmia, small-pox, and especially typhoid fever. The onset is most insidious and often overlooked. If a patient during convalescence seems to go back, loses his appetite, any embarrassment of the breathing must be at once looked for, and empyema suspected.

G. Œdema. This is often absent, though pus is present.

H. Other signs, especially in children, must be remembered—viz., unexplained and obstinate diarrhœa, emaciation, &c.

Treatment of Non-purulent Serous Effusions.—Question of operation. If medical treatment—*e.g.*, absorbents and diuretics, counter-irritation, dry, nutritious diet, &c.—fail, two questions arise: A. What is the danger of leaving the fluid? B. What is the risk of paracentesis?

A. *Danger of leaving the fluid.*

1. There is the risk of sudden death when a large, quiet effusion persists.†

Dr. Moxon showed that the effect of the effusion varied with the side affected. Thus an effusion into the right chest not only pushes the heart over to the left, but also compresses the right auricle, and so shuts off blood from the heart, thus tending to produce syncope from cardiac anæmia. Effusion on this side also tends to make lateral pressure on the inferior vena cava, which is the more readily bent over, as it has just passed through a rigid ring. Effusion into the left chest drives the heart over to the right, and, pressing on the left auricle, distends the right side of the heart, by impeding the passage of the blood into the left ventricle, and thus tends to bring about syncope from cardiac plethora. There is also a tendency for the right lung to become œdematous and crepitant, owing to its being engorged with blood.

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think of empyema rather than of the other causes of clubbing—viz., chronic bone disease, bronchiectasis, and congenital heart-disease" (Barlow).

* In children the pleura seems to have a tendency to form pus (Goodhart).

† I think it is Dr. Clifford Allbutt who records the case of a girl who had been brought to the Addenbrooke Hospital with a large, quiet, serous effusion. Having got out of the cart which had brought her, she was walking slowly across the green in front of the hospital, when, without a cry or a stagger, she was seen to fall dead.

2. The lung may become more and more tied down by adhesions—*e.g.*, when much lymph has formed.

3. The sound lung may become engorged, especially if the patient is submitted to a chill.

4. There is the risk of slow pus-formation, especially in a patient much let down, where the effusion is secondary to some other disease, and where there is the history of a chill.

B. *The risks of paracentesis.*

1. Shock. This is especially probable in delicate patients with a nervous dread of the operation.

2. Syncope. A special cause of this is perhaps alteration of the position of the heart and large vessels by removal of the supporting fluid.

3. Embolism from detachment of clots in the pulmonary veins. That this is a real risk is shown by a case of Sir B. Foster's, in which clots dislodged from the right pulmonary veins caused embolism of both renal and iliac arteries, with a fatal result from albuminuria, suppression of urine, and gangrene.

Both 2 and 3 may perhaps be prevented by not drawing off all the fluid, and drawing it off slowly.

4. Œdema of the lung. This is an undoubted danger. Shortly after the tapping (the effusion being usually a large one), urgent dyspnœa comes on with frothy, serous expectoration rich in albumen. Death usually takes place in about twenty-four hours. Dr. Duffin's explanation of this is probably the correct one. The compressed lung, after the removal of a large effusion, corresponds to a limb after the use of Esmarch's bandage—*i.e.*, the vaso-motor nerves are paralysed; thus, when the lung expands, sudden stress is thrown on toneless vessels, hence the transudation of sero-albuminous fluid, equivalent to the oozing so common after removal of the bandage.

Indications for Paracentesis in Non-purulent Effusions.

1. Threatened failure of the heart's action, shown by the failing pulse, the extremities growing cold, &c.

2. In all cases, and at any date, when the fluid is so copious as to compress the opposite lung. The base of this should be carefully watched, and any expectoration noted.

3. In all cases where, with a large effusion, there have been one or more attacks of orthopnœa. Relief will be most emphatically called for when, with this history, the patient lives some distance off, when he is no longer young and the chest no longer yielding, or when the opposite lung is at all œdematous.

4. In all cases in which a pleuritic effusion, occupying half

one pleural cavity, has existed three or four weeks, and shows no sign of progressive absorption.

Paracentesis for Serous Effusions.—Site of puncture. This is decided by: (1) Physical signs. (2) The result of the exploring needle. Common sites are: (*a*) The sixth space in front of the posterior axillary fold, a spot which has the advantage of being thinly covered, and where the ribs are well apart. (*b*) In the seventh, eighth, and ninth space behind, in the scapular line. The eighth space is here very frequently used.

The patient being turned somewhat over on to his sound side, if he can bear this, and brought to the edge of the bed, or, if he must be raised, so supported that he can be readily lowered in case of faintness, the surgeon, having seen that the spot chosen for puncture is cleansed from any poultice débris, &c., and that his aspirator is thoroughly clean and in good working order, fixes his nail just above the lower rib, and holding the needle so that it cannot penetrate too deeply, plunges it straight into the pleural cavity, and brings his needle into connection with the vacuum. If the skin is very thick, and the needle slender, it is well just to make a puncture with a scalpel point. In either case it is the skin-wound which pains.

The following **practical points** should be remembered. (1) Not to catch the needle on a rib, a mistake which is easy when the ribs are close together. (2) To be sure and enter the chest cavity, a thickened pleura or false membranes sometimes interfering with this. (3) Avoiding injury to the lung, by not plunging the needle in too deeply, or by guarding the point when it has entered. Usually the lung is at a considerable distance, but when the collection is a localized one, this accident may easily take place. (4) The fluid should not be drawn off too quickly or completely; if successive vacua are required, the later exhaustions should not be too complete. The patient should always be warned against making any sudden movement or a deep inspiration. If the flow stops suddenly, it may be due to a kink in the tube, or to a pellet of lymph plugging the needle. The flow should always be stopped at once—(*a*) if the patient faints, this being due sometimes merely to the withdrawal of a large amount of fluid, sometimes to the consequent displacement of viscera; (*b*) if any blood suddenly appears in the fluid, this coming usually from the rupture of vascular adhesions, more rarely from a wound of the lung; (*c*) if an irritating cough is set up, this being due sometimes to the unfolding of a temporary compressed lung.

When the needle is withdrawn, the puncture should be at once closed with collodion and iodoform.

If an anæsthetic is asked for, it may generally be safely given with attention to the precautions given below (p. 590). But, as a rule, the pain is so momentary that this is not needful. I have been disappointed with the results of injection of cocaine. With a nervous patient the spot may be numbed by a freezing mixture of ice and salt, or with the ether-spray. A little stimulant should be given before and after the operation.

EMPYEMA.

The frequency of this in children* has been already alluded to.

At this time of life the prognosis is good, as the lungs are free from morbid changes. The formation of pus may be very rapid at this early stage of life, pus being present by the fourth, fifth, or seventh day. The importance of this is considerable. With pus lymph is present also, and thus—(*a*) the pleura is soon altered, thickened, and less prone to heal; (*b*) the lung becomes tied down; (*c*) the drainage-tube is readily blocked; (*d*) this lymph leads to subdivision of the cavity, and so to difficulty of thorough drainage and obliteration. All this shows the necessity of early and free incision.

Another important point is, that pus in the pleural cavity is frequently localized and encysted in children. This is not uncommon in the middle third of the thorax, the pus being limited above by adhesions, and below by the fixing of the lower lobe to the chest wall. Thus, at this spot loud bronchial breathing and modified resonance may be present. Finally, in children small multiple collections are not uncommon.

The surgeon will very likely be asked the question, whether the pus need be withdrawn, and if it will not be gradually absorbed. The chances of this are extremely small, and the risks of leaving it very great. They are—(*a*) external perforation, leading to the unfavourable results of insufficient drainage, caries, and amyloid disease. The most likely sites are—in front, above and below the nipple; antero-laterally, in the fifth space, just outside the rib cartilages. (*b*) Lung perforation, leading to gangrene and hectic. (*c*) Tuberculosis, if the belief is correct that an old empyema, even if caseated and inspissated, is still infective.

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* Out of forty-four and sixteen consecutive cases of pleuritic effusion at Great Ormond Street, Dr. Barlow found twenty-seven and fourteen to be purulent.

Treatment of Empyema.

A. **Simple Puncture with Aspirator or Fine Trocar.**—This is seldom curative. The liability of the cannula to become plugged, and, usually, the need of repetition, are serious objections. It is justifiable in a few conditions—(*a*) if the patient is very young or very timid ; (*b*) if the collection is very small, or multiple ; (*c*) if the patient is healthy, the pus sweet, and the refilling slow ; (*d*) punctures may "coax pus to the surface" (Goodhart). Patients thus treated should be watched for some time. In a few cases preliminary aspiration is very useful—*e.g.*, in very large empyemata of sudden formation. Here a free incision may be followed by urgent dyspnœa from displacement of viscera.

B. **Sub-aqueous Drainage.**—This method, formerly much in use, is now rarely seen. One end of a long piece of india-rubber tubing is introduced, through a large cannula, into the chest, while the other end dips into some antiseptic solution. *Advantages:* (1) The method is simple and little painful. (2) The tube is usually well tolerated, and (if secured) follows the movements of the patient. (3) The drainage can be made gradual and adapted to the expansion of the lung. (4) It is readily converted into a siphon for washing out the chest. I look upon this last as of very doubtful advantage, believing that, if the pus is fetid, a free opening should be made at once, and that washing out the chest is always risky, and meddlesome and uncalled for when the pus is sweet. The *disadvantages* are—(1) The tube, necessarily small, is easily blocked. (2) Ulceration soon takes place around the tube, and thus air enters, or the tube slips out. It is allowable in children, or in very nervous patients, where the collection is neither great nor of long standing, and the lung will therefore be able to expand gradually.

C. **Incision.**—This is the method most frequently required, especially in adults, when the pus is thick and caseous, when it is fetid, and when it re-accumulates after aspiration quickly. The *advantages* are, the free drainage which it gives, and the facilities for washing out the pleural cavity (if this is required). The *disadvantages* are, its severity and the tendency to close. The question will often arise whether a single or a double opening is required. *A single opening* is usually sufficient in children and in young adults, owing to the healthy condition of the parts, and the natural tendency to obliteration of the cavity. The sites usually chosen are the eighth or ninth space in the scapula line, or in the same spaces anterior to and below the scapula angle. I prefer the latter in adults, as the chief part of the opening is anterior to the latissimus dorsi, an incision through this muscle, in adults, having certainly the risk of causing oozing afterwards, which may be very serious in a weakly patient. *A double opening* is occasionally required—*e.g.*, in very large cavities in adults, when the pus is fetid; when the case is of very long standing; when the ribs are very close together; when the pus is pointing high up and anteriorly, and thus the drainage is inadequate. The best instrument to cut upon in making the counter-operation is a No. 10 silver catheter, or a uterine probe. To either of these a drainage-tube can be attached by silk, and easily drawn into place.

The Chief Points of Importance in Incising an Empyema are the following:—Amongst the first will arise the question of giving an anæsthetic. Speaking from an experience of 38 cases, in 34 of which an anæsthetic was given, I believe that an anæsthetic may be safely given in the vast majority of cases. On the whole, I think that chloroform is the most suitable, on account of the greater struggling (undesirable with viscera displaced), the dyspnœa from the mucus set up, and the subsequent bronchitis after ether, but I am certain that the way in which the anæsthetic is given is of more importance than the anæsthetic itself.

Of the 34 cases alluded to above, I have only known bad results follow the anæsthetic once—a case of large empyema with pyo-pneumothorax. The heart was displaced to the right side, the face and lips somewhat cyanotic, the extremities cold, and the pulse almost imperceptible. Although the dangers of an anæsthetic were put before him, the patient insisted on having one administered. On the whole, I thought ether the safest, because of the condition of the pulse. It was administered carefully, but caused coughing. The pus was thus sucked into a bronchus, up into the trachea, and thence drawn down to the opposite lung, causing death rapidly. Artificial respiration expelled, during expiration, pus from the trachea.

As this patient was almost moribund before the operation, I now much regret the giving of an anæsthetic. It would doubtless have been wiser to have refused one, and to have trusted to minimizing the shock by exhibiting a stimulant, and by a rapid operation. A year later I was asked by my old friend Dr. Goodhart to operate on a somewhat similar case. This patient was also young, and there was here, too, a communication with the lung, the pus being, in this case also, fetid, but the pulse was good and there was no cyanosis. Chloroform being given, the empyema was incised by Mr. Nicholson, the clinical assistant, under my supervision. Chloroform in this case was taken well, the discharge quickly became sweet with iodoform dressings frequently renewed, and the patient made a rapid recovery.

The injection of cocaine is worth a trial, but, as I have stated above, it has disappointed me. While an anæsthetic is only really necessary where two openings have to be made, or where a rib is to be resected, yet its administration in capable hands is usually so safe that I always make use of it.

The patient being supported over the edge of the bed or table, partly rolled over on to the sound side, or, if this is impracticable, being suitably propped up, the surgeon, having cleansed the part, fixes a finger-nail just on the upper margin of the lower rib in the space chosen, and makes an incision down to the muscles for 1½ to 2 inches, just above his nail. This incision having exposed the muscles, a steel director is driven through into the chest wall, care being taken not to plunge it too deeply. A pair of dressing-forceps is then run along the director and opened widely both horizontally and vertically. Owing to the gush of pus which is now violently expelled, it is well to throw a piece of lint, out of carbolic solution (1 in 20), over the wound, while the pus is escaping.* The opening is next thoroughly dilated by one or two aseptic fingers, and the size of the cavity, the proximity of the lung, and the degree of granulation-formation all investigated. A large-sized drainage-tube is then inserted, and carefully secured *in situ*. One of the simplest, and, at the same time, an entirely efficient plan, is to pass two loops of silk through the outer end of the tube with a needle, knot these loops, and then place in them bundles of gauze strips. After a few days a smaller size, of the shape (on a large scale) of a tracheotomy tube, may be worn.

Hæmorrhage during the operation is usually slight, and gives no anxiety afterwards. If any point give trouble, resisting ligature, after picking up the tissues with Spencer Wells' forceps, a pair of these left on for twenty-four hours will probably meet the case: a bit of a rib quickly resected will give access to a wounded intercostal. The importance of not cutting through a thick muscle like the latissimus dorsi has already been alluded to (p. 590).

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* Occasionally, if the patient struggles, air is drawn into the pleural cavity after the escape of the pus, and then is expelled into the connective tissue of the wound, constituting emphysema. This will all pass off spontaneously. I have very recently met with a case of much more marked emphysema under the following conditions:—Being asked by my colleague, Dr. Pitt, to incise the chest of a child who, after lobar pneumonia of the right lung, had rapidly developed empyema on the same side, I noticed that, after an incision at the angle of the scapula, the usual violent outgush of pus—itself free from blood—was immediately followed by frothy blood and a markedly emphysematous condition of the wound. I believe that here the lung-tissue, damaged by previous inflammation, had given way when the pressure of the fluid upon it was removed. A few days later it was evident that the lung had become adherent around the incision, which communicated freely with an opening in it, and that the emphysema had subsided. The case did well.

The opening must be sufficient, and, if there is any doubt about this, a part of a rib should be resected without hesitation, especially where these are very close together, or where the pus is foul (*vide infra*, p. 594).

If the question of washing out the cavity arise, probably from the discharge being foul, it should be remembered that this proceeding, however gently done, has occasionally brought about grave and even fatal results very suddenly. Whether these have been due to absorption, reflex nervous disturbance, or to dislodgment of thrombi, is uncertain, but it is beyond question that in several cases symptoms of impending collapse, and even death, have followed on washing out an empyema, and that, too, in a patient who is well on in convalescence. Again, it cannot be too strongly insisted upon that fœtor calls for a freer opening, not for washing out. If, however, it is decided to make use of injections, dilute and bland ones—*e.g.*, Condy's fluid—should be used, and these should be gently run in with a funnel and tubing, and not thrown in with a syringe. A long period of drainage is often needed in adults, while in children the tube can be quickly shortened. In both sufficient tubing should be retained to keep the opening patent, as long as any discharge remains.

During the prolonged after-treatment everything should be done to improve the general health. Change of air is here a cardinal point, first, getting the patient from his room, then outside the house, and, lastly, if possible, to the seaside.*

A point of no small importance in the after-treatment, especially in young subjects with flexile spines, is to encourage early, systematic, deep breathing, and gymnastic exercises, and thus to promote expansion of the chest, and so to minimize that sad sequela of empyema, irremediable lateral curvature.

Before leaving the subject of the operative treatment of empyema, a few words should be said about the dressing of these cases. This should be strictly antiseptic from first to last. The spray is not essential if strict attention be paid to more important details—*i.e.*, cleansing the parts incised, disinfection of instruments, taking care that the pus escapes under an antiseptic atmosphere, p. 591, a sufficiently free opening, adequate drainage, abundant dry, aseptic gauze dressings, changed twice perhaps in the first twenty-four hours, and then daily for the first week. Later on, when the patient is going to the seaside, he can easily be instructed to remove and cleanse daily the short piece of drainage-tube which keeps the external opening patent, and to apply over the sinus a dressing of boracic-acid lint and carbolized tow, with a dusting of iodoform.

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* "Last, and most important of all—unfortunately for hospital patients a treatment that cannot often be utilised—comes *Margate air*. Any seaside air is beneficial, but, weather and season permitting, I do not believe there is any corner of England so quickly restorative to children with empyema as that in which Margate and Broadstairs are situated; and, personally, I set more store by a change of this kind after the first three or four weeks have passed than in any continuation of antiseptic dressings" (Goodhart, *Dis. of Children*, p. 345).

Complications of Empyema and Reasons for Cases not Doing Well.

1. Persistent septic condition, in spite of two openings, free drainage, &c.

2. Tubercular disease.

3. Lung mischief on the opposite side—*e.g.*, broncho-pneumonia, bronchitis. This is especially dangerous in patients over forty.

4. Long duration of the case, a free incision being deferred, or aspiration dallied with.

5. Caries of the ribs. Multiple spontaneous openings, with burrowing sinuses beneath the skin.

6. Age. From the feebler powers of repair, and the more rigid condition of the chest as life advances.

7. Cardiac dilatation.

8. Inflammation of other serous membranes.

9. Size of the empyema. The smaller and the more localized the collection, the better the prognosis.

10. Collection of pus forming in the opposite pleura.

11. A broken-down constitution. Intemperance. Kidney disease.

12. Mr. Godlee (*Dict. of Surg.*, vol. i. p. 459) reminds us that a curious complication of septic cases—viz., cerebral abscess—has been noticed in a sufficient number of instances to make it impossible to overlook the possible association of one with the other. Judging from Dr. Fagge's remarks on thoracic disease as a cause of cerebral abscess (*Prin. and Pract. of Med.*, vol. i. p. 546), it would appear that disease of the lung itself is oftener the primary lesion upon which the abscess of the brain depends.

RESECTION OF RIBS.

Indications.—These are chiefly:

A. Caries of ribs.*

B. In certain cases of empyema.

C. For wound of intercostal artery.

A. In obstinate *caries*, where more than one rib is affected, where previous treatment, including gouging, fails, resection should be at once performed. It is a very simple operation in these cases, as the soft tissues are nearly healthy and the periosteum is retained.

An incision, about 2 inches long, being made over the centre of the carious rib, and the muscles peeled off with a blunt dissector, the periosteum is next incised, and separated from the upper and under aspect with an elevator, blunt and slightly curved, so as to pass readily under the rib and lever it upwards. The rib being thus raised, it is easily divided at one limit of its exposed part, either with a narrow-bladed saw or with slightly curved cutting forceps. The soft parts are next peeled away from the under aspect, and the rib divided at the corresponding spot and removed.

B. In certain cases of *empyema—e.g.*, (1) when the drainage is insufficient, the discharge foul, in spite of one or two free openings; (2) when the ribs are too close together, for a tube of sufficient size; (3) when an empyema cavity still persists, though sweet, in spite of free incision, good drainage, and careful dressing. In the first two classes of cases removal of a small piece of one or two ribs will be sufficient, but in some of these latter cases the operation will necessarily be a much more severe one. When called to a case of persistent sinus and discharge after the incision of an empyema, the surgeon on examination may find that the cavity which remains is small, and that the discharge is due to a persistent sinus only. This should be dilated up with laminaria tents, part of a rib removed, and both sinus and cavity thoroughly scraped out with sharp spoons.

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* In this most tedious affection, prone to resist other treatment and often provocative of lardaceous disease, resection of the ribs should be resorted to much oftener than has hitherto been the case. Apart from cases of "strumous" origin, I have resected parts of the fourth, fifth, and sixth ribs, keeping up persistent mammary sinuses, the caries being here due to old abscess of the breast. In another patient I twice resected ribs in operations for extirpation of recurrent cancer of the left breast. Strict antiseptic precautions can alone justify this, as the sal alembroth dressings were placed in immediate contact with the lung and pericardium. The patient is as yet without further recurrence, two years after the resection of the ribs, and eight after the primary operation.

But in the majority of cases of long-standing empyemata the condition of things is not so simple and so easily dealt with. Obliteration has taken place often very imperfectly, owing to the lung not being able to expand, to the ribs having fallen in all they can, to the diaphragm having risen, and the opposite lung, heart, &c., having come over as far as they are able, while the cavity, often large, which thus remains, is lined with much thickened scar-like tissue, covered with granulations of but poor vitality. Here portions of several ribs must be removed and the operation perhaps repeated, in order that the walls of the cavity may still further collapse, and thus obliterate the cavity while an opportunity is given for exploring this thoroughly.

The spot chosen for the resection of the ribs should be, as far as possible, opposite to the lung which can expand no more, and the pieces of ribs removed should correspond as closely as may be to the anterior and posterior limits of the cavity which it is desired to close.

It has been thought by some that the amount of rib to be removed should correspond pretty closely to the distance between the two pleuræ. Thus it may be needful, especially in an adult, to remove pieces of five or six ribs, $3\frac{1}{2}$ inches being removed from some and 1 to $1\frac{1}{2}$ inch from others.

Dr. Fenger, of Chicago (*Med. News*, November 13, 1882), finds first the shape and extent of the cavity. He considers that a cavity which extends transversely requires resection of a large piece of one or of a few ribs, the largest piece taken being that from the rib which overlies the centre of the cavity. A vertical cavity covered by five or six ribs will need resection of small pieces of several ribs, from $\frac{4}{5}$ to $2\frac{1}{5}$ inches of bone being removed.

The ribs to be resected may be exposed in one of two ways. One, and I consider this the safest, is to make two or three incisions, two being usually sufficient, and to raise flaps comparatively small in size. The other is to raise a single large flap, containing in it any muscles—*e.g.*, pectoralis major and serratus magnus—which overlie the ribs to be removed. This latter plan has the high authority of Mr. Godlee, who has done much to introduce this operation into English surgery, and who has had much practical experience at the Brompton Hospital. While desirous of attaching all proper weight to the above opinion, as the operation is one of considerable severity, and the patient often far from a strong one, I prefer to use the operation of multiple small flaps, rather than one large one on account of the hæmorrhage being much less.

In raising his large flaps, Mr. Godlee does not think it worth while to spend much time in trying to stop the hæmorrhage, which is often free at this stage, as it is very difficult to do so, and as it will cease after removal of the ribs. While this last remark is quite true, I look upon the hæmorrhage, which must occur with large flaps, as not a light matter in the patients with whom we have to deal.

I much prefer, in removing four or five ribs, to make one incision between two, to deal with these, and then to make another over the centre of the three which remain. Small incisions being made at right angles to the long ones, and flaps of skin and fascia, parallelogram in shape, raised, the muscles are then peeled off each rib with a blunt dissector or slightly curved elevator. Care must now be taken to leave the periosteum on the rib (the only safe guide being not to strip off all the muscles), and by no means to detach it. If it be left behind, it will throw out callous material, which will be as unyielding as the bones removed. The elevator is then slipped under the rib, run along, close to its posterior aspect, to one limit of its bared surface, and the rib divided here either with a narrow strong-backed saw—an osteotomy saw or a Fergusson's jaw-saw answers the purpose excellently—or with cutting forceps. The rib being then raised up when cut, is divided again at a corresponding spot, and as many as is desirable treated in the same way. Each piece of rib should show clean-cut surfaces at either end, and be covered with periosteum.

Mr. Godlee advises removing as much as possible of the thickened pleura, which is now exposed, and, with it, any periosteum which has been left behind. Some square inches of this may be taken away without fear of serious hæmorrhage, if it is snipped through gradually with curved blunt-pointed scissors, the vessels met with being easily secured.

The cavity may now be thoroughly explored with the finger or a soft catheter. If fetid, or lined with ill-formed lymph, it may be gently scraped out with a sharp spoon, great care being taken when this comes in contact with important parts, such as the pericardium, root of the lung, &c. Iodoform mixed with finely powdered boracic acid should be blown in, and, where there is much fœtor, the *ends* of the gauze strips with which the cavity is plugged should be wrung out of turpentine. Drainage-tubes are then inserted, if needful, and if a large flap has been raised, this is secured *in situ* with a few points of suture. If, on the other hand, as recommended here, multiple small flaps have been raised, no sutures should be inserted, as primary union cannot take place, and discharges might be pent up.

The wound, at the bottom of which probably lies the lung covered over only with visceral pleura, is lightly filled with strips of aseptic gauze or boracic-acid lint, and salicylic wool or carbolized tow retained with a many-tailed bandage. If strict precautions are taken by cleansing the instruments, irrigating carefully, and keeping the wound covered with carbolized lint whenever practicable, the spray need not be used, and a source of chill and shock thus avoided.

With regard to the date at which ribs should be partially resected in long-standing cases of empyema, most surgeons who have seen much of these troublesome cases will, I think, agree that the operation should be performed as soon as the natural powers of obliteration are at a standstill, care being taken that the patient has recovered from the effects of the first operation, and perhaps recruited his strength at the seaside.

Estlander, who first introduced this operation, advises, on the other hand, that the operation should not be made use of too early, as he considers it essential that the two layers of pleura should be changed into thick, firm connective tissue, for the operation to succeed. Thus an interval of about six months after the formation of the empyema would seem, according to this view, to be the proper time for resection of ribs; but, on the other hand, too unyielding a condition of the chest walls, too thick a layer of scarred pleura and pyogenic membrane are conditions not to be waited for.

C. *Wound of Intercostal Artery.*—When hæmorrhage from one of these vessels cannot be otherwise dealt with, removal of a rib will give much readier access to the spot, and a ligature will arrest the bleeding far more satisfactorily than the ingenious devices mentioned in the text-books.

CHAPTER III.

DRAINAGE OF LUNG-CAVITIES.

Indications.—Operative interference is justifiable where there is a lung-cavity due to bronchiectasis, gangrene,* or hydatid, and most of the following conditions are present.

When previous treatment has failed, when it is evident that the cavity is insufficiently drained through a bronchus,† and the consequent abundant muco-purulent, fetid expectoration exhausts the patient, with harassing cough, irritative diarrhœa, and commencing hectic. When the cavity is limited and can be accurately localized,‡ when the surrounding lung-tissue is not yet infected, and the opposite lung is healthy. When the cavity is sufficiently near the surface to be got at, and when it is in a region that can be safely attacked.§ When that part of the pleural sac which overlies the lung-cavity is obliterated.‖

The two American writers quoted below show that adhesions may be expected when the abscess cavity is large, or where several attacks of disease have occurred in that part of the lung in which the cavity now exists. If the surgeon is in doubt as to the condition of the pleura here, he should make an incision down to the intercostal muscles, pass a needle into the lung, and watch it during respiration. If it does not move synchronously with this, there are certainly adhesions.

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* Mr. Godlee (*Lancet*, 1887, vol. i. p. 459) is of opinion that most gangrenous abscesses are the result of acute pneumonia, and situated near the bases. The occasional existence of a foreign body as a cause of the trouble—viz., a piece of bone or a blade of grass, &c.—should not be forgotten.

† If the surgeon wait too long in dealing with a gangrenous abscess, fetid fluid from this may, by getting into the bronchi, reach the other lung, and set up most serious damage there.

‡ In other words, when the whole bronchial tree is not dilated in one and perhaps both lungs (Dr. Williams, *Med. Chir. Trans.*, vol. lxix. p. 317).

§ Drs. Fenger and Hollister, of Chicago (*Amer. Journ. Med. Sci.*, 1882, vol. ii. p. 370, a paper which will well repay reference), point out that a cavity covered by the scapula, or in the supra-scapular region, must be at present considered inaccessible. Access can be best got from the mammary and axillary regions.

‖ This point is of the greatest importance, chiefly from the probably foul nature of the cavity contents, and the risk of setting up a fetid pyo-pneumothorax when the lung-cavity is opened, and even graver and much more urgent danger from cutting into a healthy pleural cavity.

The co-existence of empyema, of pleurisy, of a tendency to general bronchitis, will be examined into, and the amount of each and its importance in prognosis duly weighed. Finally, come more general points—*e.g.*, the age of the patient and the history.

In endeavouring to estimate the size of the cavity before exploring it, the following possible fallacies will be remembered :—

Dr. Williams (*loc. supra cit.*) points out that (1) the empyema which invariably accompanies the globular form of bronchial dilatation often entirely masks the physical signs of a cavity, even when the patient's sensations and the amount and character of the expectoration point to the presence of a bronchiectasis; (2) That the character of the cavernous sound heard over bronchial dilatation is so jarring in tone that it is audible over a far larger area of chest wall than that immediately overlying the cavity. On this account the size of the bronchiectasis is often thought to be larger than it eventually proves to be. This jarring note is more common in bronchiectasis associated with interstitial pneumonia and fibrosis than in the globular bronchiectasis accompanied with chronic bronchitis and empyema.

Mr. Godlee, in his lectures, to which I have already referred, shows that the amount of expectoration is no criterion as to the size of the cavity, as each pellet irritates the bronchi in its way over them, and causes a great secretion of mucus.*

Operation.—The anæsthetic should be given slowly to avoid coughing, and the patient kept on his back as much as possible, these two precautions being intended to prevent fluid, coughed out of the cavity, dangerously obstructing the bronchi.

If the exact position of the cavity is doubtful, a preliminary aspiration or exploring trocar-puncture† should be made use of.

An incision 1½ inch long‡ is then made, taking the needle or trocar, if used, as a guide, in the middle of an intercostal space down to the muscles, which are next torn through. The lung-tissue with the overlying pleura§ is, perhaps, best opened with a medium-sized trocar and cannula, and the opening then dilated with dressing-forceps. The finger is then gently inserted to ascertain whether any dead cast-off lung-tissue* is present, and to find out the lowest point at which to make a counter-opening.†

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* Thus, he has cured by incision a cavity which, really holding only an ounce, caused expectoration of more than a pint.

† With reference to this step, Mr. Godlee's remark should be remembered. "It is impossible to penetrate the lung with any amount of accuracy or definiteness, because it recedes before even the sharp point of a needle."

‡ It is wise to make a sufficiently free incision to prevent the risk of subcutaneous emphysema. In one case fetid emphysema took place and disappeared.

§ In addition to the aids already given for deciding as to whether the pleura is

A full-sized drainage-tube should be inserted, soft, for fear of hæmorrhage from friction and ulceration, and sufficient aseptic dressings, iodoform or sal-alembroth gauze with salicylic wool, applied.

As a cavity which gives unequivocal evidence of its existence may be missed‡ by making one puncture and then incising at that spot, and as the exploring finger or director may push the cavity to one side, the lung should be explored at several spots if needful. If the pleura is not adherent over the cavity, it will be but little good stitching the lung so as to obliterate the pleural sac here, as stitches so used are very difficult of insertion and soon cut out (Godlee). If any foul fluid escape into the pleural cavity, this must be treated like an empyema (p. 589).

Hæmorrhage is not commonly met with after puncturing the lung, as this is probably solidified and altered round the abscess cavity. If it be severe, the cavity must be plugged with aseptic gauze wrung out of turpentine. When any rotten lung-tissue has been removed with the finger, hæmorrhage is to be expected.

If the cavity be due to an hydatid, the cyst-wall may perhaps be expelled when coughing is set up by the incision of the cavity. If it does not so come away, it should be removed, if this can be effected, without setting up hæmorrhage. A good instance of

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adherent or not the state of the intercostal spaces may help, *i.e.*, whether they are depressed on deep breathing.

* Rokitansky (*Path. Anat.:* Syd. Soc. Trans., vol. iv. p. 96) speaks of having met with a walnut-sized piece of dead lung in circumscribed gangrene of that viscus. Wagner (*Berl. Klin. Woch.*, September 6, 1880) removed a piece of gangrenous lung-tissue by an opening made for evacuating an empyema, the patient recovering. In some cases broken-down lung-tissue may be all that is met with, very little fluid, if any, being present.

† It is wiser to make two openings, one at the most superficial part; then from this to explore the cavity and to try and find the lowest part for making a counter-opening, and thus to secure complete evacuation. Simple drainage with a single opening is often not sufficient, washing out being usually required to arrest the fœtor. If this washing out be done from a single opening, the fluid, having no escape, irritates the bronchi and sets up much cough. The counter-opening is best made on some unyielding body, such as a sound. Occasionally the cavity comes to the surface at several points.

‡ It is possible that, after such a fruitless exploration and the insertion of a drainage-tube, pus may burst into it, as happened in Dr. Cayley and Mr. Gould's case (*Med. Chir. Trans.*, vol. lxvii. p. 209), but this did not happen in a case of Mr. Godlee's, though the patient recovered. While the puncture may yield no fluid, gas may escape, showing that gangrenous lung has been reached.

how large cavities in the lung may be, when due to this cause, is given by a case of Dr. Fenger's (*Lond. Med. Rec.*, 1881, p. 327), in which he successfully operated by an incision in the third space (through adherent pleura), on a gangrenous hydatid cavity in the right lung, reaching from the second to the fifth rib, and from the sternum to the posterior axillary line.

After-treatment.—The cavity should be syringed out with a 1 in 50 solution of carbolic acid, till fœtor disappears, and then with thymol lotion. If fœtor is obstinate, gentle plugging with gauze wrung out of turpentine should be tried. The drainage-tube must be retained until the cavity has almost completely closed—*i.e.*, until the discharge has almost, and the expectoration has quite, stopped. If the tube be removed too early, refilling of the cavity, with return of fever, nausea, expectoration, &c., are certain. Moreover, as the external opening tends to close before the cavity is obliterated, any foul remaining matter which does not escape will be drawn into the bronchi and set up diffuse bronchitis and broncho-pneumonia.

The general health must be sustained, and every attempt made to secure fresh air, whether in the patient's room, or by getting him as soon as possible into another room, and out-of-doors.

Even if the operation does not save life, it may make the remainder much more comfortable both to the patient and his friends.

Dangers and Difficulties in Opening a Lung-Cavity.

1. Dyspnœa, coughing and choking expectoration with the anæsthetic, p. 599.

2. Pleural adhesions absent, p. 598, or so soft that they easily break down, the lung thus being pushed away from the ribs (Godlee).

3. Missing the cavity and damaging healthy lung-tissue. This is best avoided by careful preliminary use of an aseptic fine trocar or large morphia-needle.

4. Getting, as a result of the operation, diffuse broncho-pneumonia, pleurisy, pleuro-pneumonia, in the lung operated on or its fellow.

5. Severe hæmorrhage, causing much trouble, owing to the hæmoptysis, with the anæsthetic (Godlee), and later on setting up septic inflammation of the lung.

6. Finding a large branching cavity, with numerous caverns, difficult or impossible to drain.

7. If the bronchi are dilated and contain fluid similar to a

cavity, this may be drawn from a bronchus by preliminary puncture. This is then mistaken for a cavity, and cut down upon.

8. A cavity near the root of the large vessels.

9. Much consolidation of the lung-tissue over the cavity.

10. As a result of the operative interference, secondary rapid sloughing and gangrene of the lung may follow.

This seems to have happened in an interesting case reported by Dr. J. Smith, of Halifax (*Lancet*, 1880, vol. ii. p. 86). Decided relief and improvement followed on the opening of what was apparently a large cavity, but death took place in about a fortnight.*

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* The conclusions with which Mr. Godlee (*Lancet*, 1887, vol. i. p. 718) sums up his most valuable lectures on this obscure and difficult subject may be quoted here :—" 1. Gangrenous cavities should always be sought, and, if possible, opened; and the prognosis, if the operation be successful, is not bad. 2. The same may be said in regard to abscesses caused by the rupture of purulent collections from other parts into the lung, at least as regards the pulmonary complication. 3. Abscesses connected with foreign bodies must be opened, and, if the body be not found, it must be remembered that, if of any considerable size, it probably lies pretty near the middle line. If possible, these cases should be treated early by tracheotomy and incision. 4. Bronchiectatic cavities, when single (a very rare condition), will be cured by operation. When multiple (a very common condition), they offer but small chance of relief by our present surgical methods. Still, for the reasons stated, an attempt may be made to open the main one, if such is to be found, but only if the pleura has been ascertained to be adherent. 5. Tubercular cavities should only be opened in cases where the cough is harassing, and the cavity single. Injections may be used to relieve symptoms, but cannot be expected to be curative."

CHAPTER IV.

TAPPING OR INCISING THE PERICARDIUM.

Indications.

1. When a pericardial effusion has resisted previous treatment, and signs of cardiac distress are appearing.
2. When there is a steady increase of precordial dulness.
3. When the heart-beat and pulse are becoming feeble.
4. When there are cyanosis, dyspnœa, and epigastric distress.
5. When the effusion persists, when it is accompanied by œdema, rigors, and pyæmia, when it occurs in a much weakened patient, as part of pyæmia, the fluid is probably purulent.*

The most suitable place for puncture is, in ordinary cases, the fifth† left intercostal space, about 1 inch from the edge of the sternum, so as to avoid the internal mammary artery,‡ the instrument being a trocar and cannula, with or without aspiration according to the facility with which the fluid flows.§ A pint of serum, and in many cases over a pint, has been removed. The withdrawal of a much smaller amount—viz., 3 or 5 oz.—has been followed by recovery.‖

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* In Dr. West's case (*Med. Chir. Trans.*, vol. lxvi. p. 266), treated successfully first by tapping and then by free incision, there were no rigors or sweating, but œdema of the chest walls, most marked over the precordial region, was present. So, too, in a patient of Prof. Rosenstein's, a boy aged ten, with a large purulent pericardial effusion, the temperature was hardly above normal, and there was no œdema.

† The fourth space has also been chosen in many cases.

‡ And also to avoid opening the pleura. When this is adherent to the pericardium, the tapping or incision can, of course, be made farther out. But Dr. West, who chose the nipple line for his puncture and opening as the spot where the heart was farthest from the chest walls, found that a long sinus formed—an argument for puncturing nearer the sternum.

§ In Dr. West's case the pus was very viscid, and flowed slowly; the cannula was accordingly connected with the aspirator, and about 14 oz. obtained.

‖ With regard to the amount to be withdrawn, Dr. Stewart (*Edin. Med. Journ.*, August 1885) thinks that, if serous fluid is found, aspiration should be made use of, but only enough withdrawn to give relief. He points out that it is a sound rule, in dealing with vital organs, that only a minimum amount of interference should be had recourse to, and that this is especially necessary in cases which threaten pulse-failure. The tapping should be repeated rather than too much fluid be drawn off at once.

Dr. Goodhart points out to me that the position of election is still an open question, each case calling for a decision by itself. The puncture has been made in the fourth or fifth space in the left nipple line, or even beyond this. Dr. Goodhart considers that the second of the above sites would give the best drainage with least disturbance to the heart if the effusion were sufficient to allow of the above space being chosen. This method involves going through the pleura, and if this serous space contain fluid, the surgeon may evidently be mistaken in thinking that he has reached the pericardium. This has happened twice, to my knowledge, each being a case of thoracic growth. In one of them, a case of mine, the pleura was opened by tapping in the fourth space, just outside the sternum; the fluid which flowed was thought to come from the pericardium, until an autopsy proved that this sac was intact. Such cases prove that entering the pericardium is by no means as easy as is usually taught.

A preliminary puncture being made with a scalpel, the trocar —in the case of serum, a hydrocele trocar will probably be sufficient—scrupulously clean, should be steadily pushed, with aseptic precautions, for 1¾ or 2 inches through the chest wall, and at a right angle* to it. The trocar should then be removed, and, if fluid does not flow, the point will probably be found not to move freely in a cavity. It should then be pushed cautiously onwards, and its point at once sheathed if it is felt to touch against a soft obstacle.

On the fluid ceasing to flow, the puncture should be closed with collodion and iodoform.

Dr. West thinks (*loc. supra cit.*) that paracentesis pericardii may be performed with advantage, not only in the pericardial effusions of rheumatic or primary origin, but also in those which occur in the later stages of general dropsy, if it should appear that the fluid in the pericardium is adding to the difficulties under which the heart is placed. According to the cases which he has collected, with one exception† all the patients were much relieved by the removal of even a small amount of fluid, and many recovered completely who would probably have died if the operation had not been performed.

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* Mr. Godlee (*Dict. of Surg.*, vol. ii. p. 164) says close to the sternum, and obliquely upwards and outwards, so as to avoid wounding the heart.

† In this case, No. 51 in Dr. West's list, death took place, five minutes after the puncture, from hæmorrhage into the pericardium from injury to the right ventricle. But in another case, No. 29, the patient died two hours after the operation, the left pleura being found to contain air and blood, the latter coming from a puncture in the heart.

The co-existence of effusion into the pleuræ and peritonæal cavity in many of these cases must be remembered.

If pus is present, the case must be treated by free incision. An anæsthetic being given,* the trocar is taken as a guiding-director, and a narrow sharp-pointed bistoury carefully thrust in by its side, and the opening further dilated with dressing-forceps or a blunt-pointed bistoury, care being taken to keep the internal opening into the pericardial sac free. A large soft drainage-tube should then be inserted, and, when all the pus† that will come away has escaped, aseptic-gauze dressings should be applied.

Dr. Gussenbauer, in a patient aged fifteen, with purulent pericarditis after osteo-myelitis, resected part of the fifth rib before incising the pericardium, and the patient recovered. While this is an improvement on the now abandoned method of trephining the sternum, it cannot often be required.

Causes of Failure.

1. The heart fatty or dilated. These changes may come on very rapidly.
2. The pericardium much thickened and adherent.
3. Co-existing effusions into pleuræ and peritonæal cavity.
4. Œdema of lung. Evidence of this should be most carefully watched for. This proved fatal in the case of a patient of Dr. Goodhart's, a young lady of fourteen, from whose pericardium I removed 46 oz. of pus by an incision in the fifth right space, a little outside the sternum.
5. Co-existing diseases—*e.g.*, phthisis, or renal disease.

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* Chloroform will perhaps be the wisest, especially if pleural effusion co-exists, on account of the greater struggling with ether. It was well taken in Dr. West's case. Punctures for cocaine injection will be painful, and very likely futile.

† In Dr. West's case, a boy aged sixteen, this was estimated at 2 quarts. If the pus is foul, but not otherwise, the cavity should be syringed out with dilute carbolic acid or mercury perchloride solution.

PART IV.

THE ABDOMEN.

CHAPTER I.

LIGATURE OF VESSELS.

EXTERNAL ILIAC. COMMON ILIAC. INTERNAL ILIAC. GLUTEAL. SCIATIC. ABDOMINAL AORTA.

LIGATURE OF THE EXTERNAL ILIAC (Fig. 106).

Indications.—Chiefly:

1. Some cases of aneurism of the upper part of the femoral, or of the femoral encroaching on the external iliac itself.* Thus, ligature of this vessel is indicated where pressure, rapid or gradual, has failed to command the circulation, where it is intolerable, where it cannot be made use of owing to the abundance of fat, from failure of pulse and breathing under an anæsthetic, or from the height at which the aneurism involves the external iliac,† where the patient from chronic bronchitis is quite unfit for a prolonged trial of continuous pressure under an anæsthetic, or in cases where the increase of the aneurism is very rapid.

Before deciding on relinquishing the idea of pressure for ligature, the surgeon should refer to a paper by Mr. Wheelhouse (*Clin. Soc. Trans.*, vol. vii. p. 57). This case is one of the most interesting in all surgery. The patient, a publican, and syphilitic, had previously been cured by Mr. Wheelhouse of a right-sided popliteal aneurism,* by means of continuous pressure for eight hours with a Porter's femoral compressor. A few months later he was admitted into the Leeds Infirmary with a large right iliac aneurism,† reaching from Poupart's ligament to within 2 inches of the umbilicus, and extending outwards almost to the spine of the ilium. The swelling, about the size of a small cocoanut, was hard and firm below, soft above; it appeared to be wholly connected with the external iliac, but to extend above and overlie the common iliac. Pressure could not be made on the latter vessel sufficient to stop the beating, as the tumour was too much in the way, but it was easily controlled by pressure on the abdominal aorta. The patient was kept under the influence of ether for five hours, Lister's tourniquet being very slowly screwed down just over the umbilicus. By the end of the time the patient was black in both limbs, and blue as far as the tourniquet. This had been slightly relaxed twice. No other unpleasant symptom arose during the whole time. A quarter of an hour was taken in relaxing the pressure—a quarter turn of the handle being made every minute. The tumour had ceased to pulsate and was firm and hard. Pulsation gradually recurred with nearly its old force, but was less "distensile," and slowly ceased altogether, an excellent recovery being made.

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* Mr. Holmes (R.C.S. Lect.: *Lancet*, 1873, vol. i.) shows that in ilio-femoral aneurisms it is often very difficult to say whether the aneurism is or is not limited to the iliac or femoral—*i.e.*, whether it is wholly above or below the place where the deep epigastric and circumflex iliac come off, or whether the mouths of these vessels open out of the sac. In the former case the aneurism would be purely iliac or femoral; in the latter, ilio-femoral.

† It being increasingly difficult to apply pressure in these cases without dangerous interference with the peritonæum and its contents.

In the same volume of the Clinical Society's *Transactions* (p. 56) is a case of a large diffuse femoral aneurism, in which Mr. Barnard Holt made use of continued pressure, by means of tourniquets applied alternately to the external and common iliacs, the pressure being kept up for fifty-two hours, with varying alterations of the tourniquets, and intervals of consciousness (for about half an hour) to allow of the patient taking brandy, Liebig, and arrowroot.* Chloroform was given throughout, and cure seems to have been probable; the last report being that "the patient left the hospital, walking well with the aid of one crutch."†

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* It is very possible that the strain thrown on the artery above during the treatment by pressure on the femoral was the cause of the aneurism higher up. The liability of patients with one aneurism to develop another may often baffle the surgeon. Mr. Clutton (*Brit. Med. Journ.*, 1880, vol. i. p. 441) records a case n which a femoral aneurism was cured by the use of Esmarch's bandage applied up to the tumour, and a Pétit's tourniquet adjusted over the brim of the pelvis. The first attempt lasted an hour; at the second trial the bandage was removed n an hour, and the tourniquet continued for nine hours, anæsthetics not being given. The aneurism ceased to pulsate and began to shrink, but still fluctuated. Nine days after leaving the hospital, the patient died suddenly of an aortic aneurism rupturing into the pericardium.

† Dr. Diver, of Southsea, has put on record a case in which the external iliac was tied in a case in which a popliteal and inguinal aneurism co-existed on the ight side. Gangrene followed, a line of demarcation forming in the lower third f the leg. Amputation through the thigh was performed, and the patient reovered. A similar case of double aneurism is reported by Mr. Hilton (*Med. Chir. Trans.*, vol. lii. p. 309). A tourniquet was first applied to the right common iliac or six hours without effect on the aneurisms. A second trial of pressure was made, later on, with a tourniquet again on the common iliac and one on the femoral at the apex of Scarpa's triangle. In about nine hours both aneurisms were cured. Chloroform was used on both occasions.

In ruptured‡ femoral aneurism the old operation (facilitated by the application of a tourniquet above) would usually be indicated, but Mr. Southam has briefly reported § a case in which he tied the external iliac successfully in a patient whose femoral aneurism suddenly ruptured and became diffuse. The effused blood was quickly absorbed, and there was never any tendency to gangrene. Complete power over the limb was regained.

2. Wounds.—A wound of the external iliac is so rare as to be almost unknown.‖ It has been frequently tied for hæmorrhage from parts below—*e.g.*, for secondary hæmorrhage after wounds of the femoral high up, after ligature of the femoral, and after amputation at or near the hip. The futility¶ of this treatment

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* If sickness occurs with the anæsthetic, nutrient enemata should be given.

† Cases of Dr. Mapother's and Mr. Holden's, in which ilio-femoral aneurisms were cured by pressure on the common iliac and the aorta, will be found, recorded by Dr. Mapother, in the *Dub. Med. Press*, March 29, 1865, and by Mr. Holden, in *St. Barthol. Hosp. Reports*, vol. ii. p. 190; *Syd. Soc. Bien. Retr.*, 1865–6, pp. 306, 307. In Dr. Mapother's case, instrumental pressure on the right common iliac (about 1 inch below and ½ inch to the right side of the umbilicus) kept up for twelve hours under chloroform had failed. A second attempt, with a Signorini's tourniquet on the end of the abdominal aorta, and a Skey's tourniquet on the femoral just as it left the sac, pressure being kept up for four hours and a half, made the tumour solid and pulseless. Two rigors followed, and a carbuncle formed at the site of the first compression. In Mr. Holden's patient the aneurism was also large, and double aortic valvular disease was present. Chloroform was given here continuously for an hour and a half, and then with cautious intermissions, owing to the state of the pulse and breathing, for the rest of the treatment, which lasted four hours.

‡ In an interesting case recorded by Dr. Sheen, of Cardiff (*Brit. Med. Journ.*, 1882, vol. ii. p. 720), the femoral aneurism, for which the external iliac was tied successfully, changed its shape suddenly, having burst some of its coats, apparently, but not all, on the day of operation.

§ *Brit. Med. Journ.*, 1883, vol. i. p. 818.

‖ The only case with which I am acquainted is one quoted by Mr. Erichsen from Velpeau (*Nouv. Elém. de Méd. Opér.*, t. i. p. 175), in which the above French surgeon was suddenly called upon to tie the external iliac for a knife-wound. Though there had been no preliminary dilatation of the collateral circulation, either by pressure or by the presence of an aneurism, the result was successful.

¶ It is fair to state that Mr. Bartleet, of Birmingham, published a case in which the external iliac was tied successfully after secondary hæmorrhage from the is shown by a table in which Dr. Otis* gives a summary of twenty-six cases in which the external iliac was tied for such cases as the above. Of these, twenty-three ended fatally, a mortality of 88.4 per cent. The uselessness of trusting to ligature of the external iliac in such cases, instead of either securing the wounded vessel itself, or trusting to well-applied pressure, was long before this insisted on by Guthrie.† This question is alluded to again below, but in proof of the above statement a case‡ may be mentioned here, in which hæmorrhage returned after ligature of the external iliac, and was arrested by well-applied pressure. The patient had been wounded, January 15, 1865, by a minié ball, entering at the upper and inner part of the thigh, and emerging near the knee. The wound becoming sloughy, hæmorrhage occurred—March 23 and 31—and the external iliac was tied. April 21. Hæmorrhage recurred from the upper gun-shot wound, and was successfully restrained by a horseshoe tourniquet, constantly kept on for two weeks, when it was omitted, without any subsequent hæmorrhage. The wounds were now healing kindly, when—May 31—dysentery set in, carrying off the patient, June 15, two and a half months after the operation of ligature.

3. Elephantiasis.—Ligature of the external iliac or femoral (when the condition of the soft parts admit of it) has been extolled by some surgeons in the treatment of this affection.§ A

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common femoral, the latter having been tied for aneurism of the femoral artery. Previous to ligature of the external iliac, "sponge-pressure" and pressure by means of a Martin's bandage were tried, but no details are given. It is noteworthy that the catgut ligature applied to the femoral in this case came away on the seventh day (the first day of the hæmorrhage) unabsorbed, and surrounding a small slough of the artery. It had been tied "tightly."

* *Med. and Surg. History of the War of the Rebellion*, pt. iii. p. 788.

† *Wounds and Injuries of the Arteries*, Lects. v. and vi.

‡ Otis, *loc. supra cit.*, p. 40.

§ An apparently successful case is reported by Mr. Leonard, of Bristol. Measurements are given nearly three years after the operation, showing that the success was then maintained. Five years later the patient reported that "his leg was much the same" as at the last report. Bandaging does not appear to have been made use of here. Prof. Buchanan (*Brit. Med. Journ.*, November 23, 1867; *Syd. Soc. Bien. Retr.*, 1867–8, p. 300) reports a case, seven months after the operation, apparently cured by ligature of the external iliac, after failure of rest and methodical compression (this was before the introduction of Martin's bandage). Three months later it is candidly stated that the disease had recurred to a considerable degree. Dr. White, of Harvard University (*Intern. Encycl. of Surg.*, vol. ii. p. 631), quotes Wernher (reference not given) as having followed up thirty-two cases; in all there was an immediate reduction of size, but the relief was permanent in three only. Dr. Pinnock, of Melbourne (*Lancet*, 1879, vol. i. p. 44), gives a case in which no permanent benefit followed on ligature of the femoral artery.

larger experience shows, however, that when cases thus treated are watched, the cures cannot be relied upon as permanent. Moreover, too little value has been attached, in reported cures by ligature of the main vessel, to the thorough rest and elevated position entailed by tying the artery.*

This operation should, I think, be reserved for those cases (which will be very few) in which Martin's bandages cannot be applied owing to cracks, foul ulcers, or burrowing sinuses. Here the ligature may be used after explaining its risks to the patient, but only as a subsidiary measure. The bandage will have to be used as well later, and persisted in, during the day at least, probably for life.

4. As a distal operation in aneurism of the common iliac, ligature of the external iliac has been so unsuccessful here as to call for no further comment.

Surgical Anatomy.

EXTENT.—From the lumbo-sacral articulation to a point just internal to the centre of Poupart's ligament. LENGTH.—About 4 inches.

SURFACE MARKING.—From a point an inch below and to the left of the umbilicus to a point just internal to the centre of Poupart's ligament.

RELATIONS :— IN FRONT.

Peritonæum, small intestines.
Iliac fascia.
Lymphatic glands and vessels.
Genito-crural nerve (genital branch).
Spermatic vessels } Crossing artery near Poupart's
Circumflex iliac vein } ligament.

OUTER SIDE.
Psoas (above).
Iliac fascia.

External iliac artery.

INNER SIDE.
Iliac fascia.
Vein.

BEHIND.

Iliac fascia.
Vein (above).
Psoas (below).
Vas deferens (dipping from internal ring to pelvis).

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* A severe case of Mr. Whitehead's is briefly reported in the *Brit. Med. Journ.*, 1882, vol. ii. p. 1043. The disease had lasted seventeen years, and had been associated with attacks of erysipelas. "The treatment (successful) had consisted in rest, massage, elastic pressure, compression of the femoral artery, and rubbing down the tubercles with pumice-stone. The knee, which had become flexed and ankylosed by bony union, was straightened by sawing through the site of the original joint."

Collateral Circulation.

Deep epigastric	with	Internal mammary, lower intercostals, and lumbar.
Deep circumflex iliac	with	Ilio-lumbar, lumbar, and gluteal.
Gluteal and sciatic	with	Internal and external circumflex.
Comes nervi ischiadici	with	Perforating branches of profunda.
Obturator	with	Circumflex arteries and epigastric.
Internal pudic	with	External pudic.

Operation.—(1) By the lower and more transverse incision of Sir A. Cooper. (2) By the higher and more vertical incision of Abernethy. The two are compared at p. 614.

(1) INCISION OF SIR A. COOPER.—This is the method more frequently made use of. The diet having been limited, and the bowels having been freely moved for some days before the operation, the parts shaved, and the hip slightly* flexed, an incision is made 4 inches long (4½ to 5 if there be very much fat, or if the parts are pushed up by a contiguous aneurism), parallel with Poupart's ligament, and nearly an inch above it, commencing just outside the centre of the ligament and extending outwards and upwards beyond the anterior superior spine.† The superficial fascia and fat, varying in amount, being divided, and the superficial circumflex iliac vessels secured, the external oblique, both fleshy and aponeurotic, is cut through, and then the fleshy fibres of the internal oblique and transversalis. This is done either by using the knife alone, lightly and carefully, or by taking up each layer with forceps, nicking it and slitting it up on a director. If the wound be sponged carefully,‡ a layer of cellular tissue can usually be seen between the muscles, however thin they are. Any muscular branches should be secured with

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* So that the skin may not be too much relaxed before being incised. Later on, to relax the parts, the hips may be more strongly flexed.

† The incision may have to be made higher than usual, owing to the upward extension of the aneurism, to enable the surgeon to tie either the upper part of the external or the common iliac. On this point see the remarks on the comparison of Cooper's and Abernethy's operation, p. 614. Often in these cases of upward extension of the aneurism, the sac is found to involve the lower part of the artery, and to have overlapped the upper portion.

‡ In some cases where the circulation has been much interfered with by an aneurism, most copious hæmorrhage, especially venous, has been met with in the earlier steps of this operation.

Spencer Wells' forceps as soon as cut; and in pushing a director beneath the muscles as little damage as possible should be done, owing to the proneness to cellulitis later on, and to the proximity, in a thin patient, of the peritonæum. The fascia transversalis, when exposed, will be found to vary a good deal in thickness and in the amount of fat which it contains. It is to be divided very carefully,* and the extra-peritonæal fat, if present, will next come into view. First one and then two fingers being introduced, the peritonæum is to be gently stripped up from the iliac fossa towards the middle line—*i.e.*, upwards and inwards as far as the inner border of the psoas.† In doing this, care must be taken, especially in the dead body, not to separate the iliac fascia and the vessels from their position on the psoas, not to tear this muscle, and not to lacerate the peritonæum. As soon as the peritonæum has been well raised, an assistant keeps this and the upper lip of the wound well out of the way by means of broad retractors. The surgeon then feels for the pulsation of the artery on the inner border of the psoas, and carefully opens the layer of fascia which ties the vessel to the psoas and forms a weak sheath to it. This should be done 1¼ inch above Poupart's ligament,‡ and the needle passed from within outwards, carefully avoiding the vein on the inner side and the genito-crural nerve outside and in front. In difficult cases the ligature must mainly be passed by touch, but a free incision, adequate use of retractors, and light thrown in by a large mirror will very often allow the surgeon to see what he is doing. The effect of tightening the ligature being satisfactory, it is cut short and dropped in, the cut muscles are then brought together with chromic gut cut short, sufficient drainage provided, and the superficial wound closed. The parts must be kept relaxed by propping the chest up slightly and flexing the knees over a pillow, but too much flexion of the groin is to be deprecated as causing a deep sulcus from which discharges will escape with difficulty. The limb is evenly bandaged from the toes upwards, raised and kept covered in cotton-wool, with hot bottles placed in the bed.* In case of threatening gangrene, assistants should persevere in a trial of friction of the limb from below upwards. Where there is a history of syphilis, appropriate remedies should be given after the operation.

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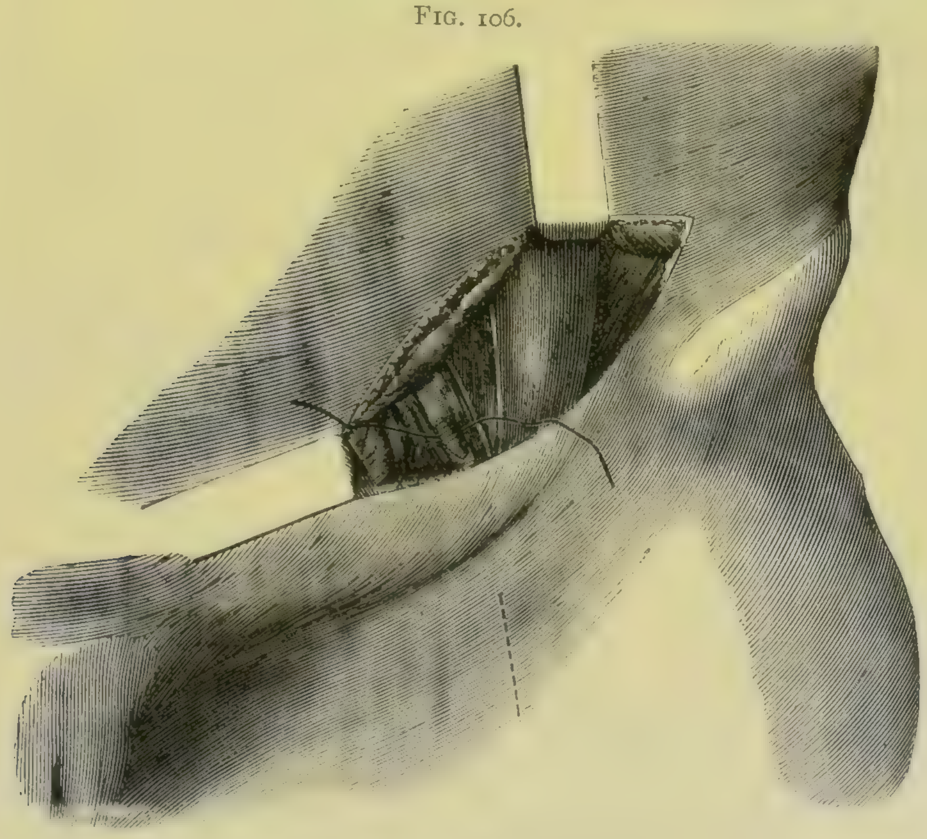
* Dr. Sheen (*loc. supra cit.*) thus writes of the accident which may happen here: "I made the incision somewhat too high, and, in consequence, opened the peritonæum, which I mistook for transversalis fascia. Even then I was in a little doubt, because some (omental) fat presented itself, which very much resembled the fat seen in the previous case (fat around the vessel), but, in pushing this up gently, a knuckle of bowel came into view, which settled the matter." The wound in the peritonæum was sewn up with two fine carbolized sutures, and the case did perfectly well.

† Great care is needed here if the peritonæum is adherent. This condition, when present, is usually found above. It is especially likely in long-standing cases, and where the aneurism has caused irritative and inflammatory changes. By some it is held that the transversalis fascia can always be stripped up along with the peritonæum. As this fascia is thickened and attached, close to Poupart's ligament, to form the deeper crural arch and front of the femoral sheath, it is very doubtful if it can ever be detached unless it is divided or torn through. The latter is very easy on an aged corpse.

‡ So as to lie well above the origin of the deep epigastric, which usually comes off ¼ or ½ inch above Poupart's ligament. The absence of any other branch should, if possible, be verified.

FIG. 106.



Ligature of the external iliac artery. The peritonæum is held out of the way above and at the two angles of the wound. Below are seen, from without inwards, the iliacus, psoas, genito-crural nerve, the artery (with a ligature beneath it), and the vein.

The incision below is that for ligature of the common femoral.

(2) INCISION OF ABERNETHY.—In his first operation this surgeon made his incision in the line of the artery for about 3 inches, commencing nearly 4 inches above Poupart's ligament. Later on he modified his incision by making it less vertical, and more curved, with its convexity downwards and outwards, and

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* If the patient be restless, as in delirium tremens, a long splint should be applied.

extending between the following points—viz., one about 1 inch internal and 1 inch above the anterior superior spine to 1½ inch above and external to the centre of Poupart's ligament.

The respective **advantages** and **disadvantages** of the methods of Cooper and Abernethy appear to be the following:—Cooper's is rather the easier, interfering, as it does, with the peritonæum less, and lower down. It is most suitable to those cases which do not extend far, if at all, above Poupart's ligament. The risk of ventral hernia would appear to be less. On the other hand, where the extent to which the aneurism reaches upwards is not exactly known, Abernethy's operation, hitting off the artery, as it does, higher up, or some modification of that given (p. 625) for ligature of the common iliac will be found preferable.

Difficulties and Possible Mistakes.

1. Too short an incision. Here, as in colotomy and other deep operations on the abdominal wall, every layer must be cut to the full extent of the superficial ones. Otherwise the operator will be working at the bottom of a conical, confined wound.

2. A wrongly placed incision—*i.e.*, one which, by going too near the middle line, opens the internal abdominal ring, or which, if too low, may come too near the cord.

3. Disturbing the planes of cellular tissue needlessly or roughly.

4. Wounding the peritonæum, owing to a hasty incision through a thin abdominal wall, by rough use of a director, especially if the peritonæum is adherent in the neighbourhood of the sac, or fused with the transversalis fascia. The peritonæum is often difficult to distinguish: it is bluish in aspect, but of course not smooth, but covered with cellular tissue which connects it to the extra-peritonæal fat.

5. Stripping up the peritonæum roughly and too far.

6. Detaching the artery from the psoas.

7. Lacerating the psoas.

8. Tying or injuring the vein.

9. Including the genito-crural nerve.

10. An abnormal position of the artery. This may be due to an exaggeration of that naturally tortuous condition of the artery which is especially likely to be met with in patients advanced in life. Another unusual course of displacement may be met with in extravasated blood, when an aneurism has given way. Sir W. Fergusson briefly reported (*Brit. Med. Journ.*, 1873, vol. i. p. 286) an instance of this kind, in which the sac gave way after repeated manipulation.

Causes of Failure and Death.

1. Gangrene. In some cases, where the limb does not become gangrenous, the vitality is very feeble and requires much attention. Thus, in Mr. Rivington's case (*Clin. Soc. Trans.*, vol. xix. p. 45), loss of sensation was noticed on the fourth day, followed by paralysis of most of the muscles. Though gangrene did not appear, and the patient survived five and a half months, the limb was "on the verge of gangrene," as shown by sores appearing on the heel and great toe.*

2. Secondary hæmorrhage. This is especially likely if the wound becomes septic and if catgut is used. This fatal result may be long deferred : thus, in Mr. Rivington's case (*loc supra cit.*), the patient died of secondary hæmorrhage five and a half months after the operation ; the wound had been found septic at the first dressing ; catgut was used. Early recurrence of pulsation may be ominous of secondary hæmorrhage. In a case of Sir A. Cooper, the hæmorrhage which proved fatal a fortnight after the operation was found to be due to a large collateral—viz., an abnormal obturator arising immediately above the site of ligature (Roux, *Parallèle de la Chir. Anglaise avec la Chir. Française, &c.*, pp. 278, 279)

3. Cellulitis. Septicæmia. Pyæmia. Owing to the number of planes of cellular tissue met with here, any needless or rough disturbance of the parts, inadequate drainage, or a septic condition supervening are extremely to be deprecated. The wound should be opened up at once if any collection of fluid is suspected.

4. Peritonitis.

5. Tetanus, from including the genito-crural nerve.

6. Phlebitis and secondary hæmorrhage from injury to the external iliac vein.

7. Suppuration of the sac with its attendant dangers of septic infection and secondary hæmorrhage.† This accident is far from uncommon in cases of inguinal aneurism after ligature. No pains should be spared to prevent its occurrence by taking every step to keep the wound strictly aseptic from first to last, and thus to

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* In one of Dr. Sheen's cases already referred to, four days after the operation a large patch of skin on the outer side of the thigh was noticed to be darkish in colour, and to pit on pressure, though normal as to sensation. The case did quite well.

† Very occasionally secondary hæmorrhage may take place to a slight amount, and leave off spontaneously. Thus, in one of Dr. Sheen's cases, five weeks after the operation "about an ounce of bright-red blood came from the slight remaining wound, and a slight oozing again after a few days, but there was no further hæmorrhage."

secure early and sound healing. Absolute rest should also be enforced upon the patient. If suppuration take place it will usually be within two months of the date of ligature. The symptoms need not be alluded to here beyond pointing out that pulsation is one of very grave omen. When it is evident that suppuration, if not established, is inevitable, the surgeon should so arrange his time as to choose a suitable occasion, both as to assistance and a good light, for interfering. Allowing the suppurating sac to open spontaneously should not be thought of, not only because of the risk of hæmorrhage, the want of preparation, &c., but because septic infection is now made very probable. The operative steps are much the same as in the old operation for aneurism, for which the reader is referred to p. 634. It may be here pointed out that in this case there is more chance of the hæmorrhage taking the form of a general oozing from the sac, and not that of a gush or spirt of blood. Moreover, if the collateral circulation has been well established, there is also the probability of the sac being fed by some additional branch, which, perhaps, entering deep down, may be a cause of much embarrassment.

8. Recurrence of pulsation. This is especially likely to occur when a catgut ligature has been used and given way, owing to its being softened by suppuration. Over-free collateral circulation will cause recurrence of pulsation quickly; and melting down of soft coagulum (this appearing to be all that the blood can do in the way of clotting) will bring about the same cause of failure later on.

In these cases, the following courses are open in the matter of the external iliac—viz., well-adjusted and carefully maintained pressure, and the old operation. Ligature of the vessel lower down—*i.e.*, between the first and the aneurism—and amputation are not available here.*

Two other conditions which may supervene and prove troublesome should be mentioned here—viz.:

9. Formation of a ventral hernia. This should be prevented as far as possible by ensuring primary union, and by the use of

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* In one case (*Syd. Soc. Bien. Retr.*, 1873–4, p. 220) after ligature of the external iliac for a femoral aneurism with catgut, and premature absorption of this on the fifth day (the wound suppurated freely, and antiseptic precautions do not appear to have been taken), pulsation returned, and the swelling enlarged. The patient was operated upon again, and a stout carbolized hempen ligature made use of, one end being left long. Though, owing to the close matting of parts, the peritonæum was wounded twice, and intestines and omentum protruded, the patient recovered.

deep chromic-gut sutures in the cut muscles. Later on, if this complication threaten, an appropriate belt should be worn.

10. Coming away of the ligature long after the operation through a persistent sinus or re-opened wound. This may happen, even in a wound kept sweet from first to last, if a silk ligature has not been properly carbolized, or if one of too close texture is used. See the foot-note, p. 457.

LIGATURE OF THE COMMON ILIAC (Fig. 107).

Indications.—Very few:

1. Aneurisms. Especially those inguinal aneurisms which affect the external iliac in its upper part, above the origin of the deep epigastric, occupying the iliac fossa and lower part of the abdomen. When such aneurisms are progressing steadily, when they have resisted a trial of pressure, and are not thought amenable to the old operation, ligature of the common iliac is indicated.

The following remarks by one of the chief living authorities on aneurism, Mr. Holmes (R.C.S. Lectures, *Lancet*, 1873, vol. i. p. 297), will aid the surgeon in coming to a decision in this most important matter:—

"Allowing that an iliac aneurism is amenable to all three methods of treatment—the Hunterian, by ligature of the aorta or common iliac; the old operation, by laying open the sac and securing the artery or arteries opening into and out of it; and the method of compression applied to the aorta or common iliac—I think no one could deny that the number of cures by the latter method bears a very large proportion to the number of cases treated, while the cures by the Hunterian method are very rare, and the other method is as yet pretty nearly untried.

"But this is far from settling the question; compression, doubtless, often succeeds, but it also often fails. It is not without its risks. It usually requires the prolonged use of chloroform, and this cannot always be borne by the patient.

"The question of applying the old method in preference to the Hunterian in those cases (rare, it may be, but which must sometimes be met with) in which pressure has failed, is one which Mr. Syme's brilliant operations have put in a totally new light. And, I must say, for my own part, that, looking at the awful mortality which has attended the ligature of the common iliac for aneurism, and the uniform fatality of the same operation on the aorta, I think Mr. Syme's suggestion ought to be put to the test of more extended experience, although the facts and reasonings which I have adduced will show that I am not insensible to the risks which attend the performance of the operation, to the probability of secondary hæmorrhage, and to the extensive injury which must be inflicted upon parts in the immediate neighbourhood of important organs."

Mr. Holmes, then, in proof of the great fatality of the Hunterian operation on the common iliac, quotes the list collected by Dr. Stephen Smith (*Amer. Journ. Med. Sci.*, July 1860, vol. xl.), in which, out of fifteen cases in which that vessel was tied for aneurism, only three can be reckoned as definitely cured.

Mr. Holmes' belief that subsequent experience has not been more favourable is supported by a table of 65 cases, tabulated by Dr. Packard.* Of these 65 cases, no fewer than 51 died, only 14 recovering, giving a general mortality of 78.46 per cent.†

Mr. Holmes goes on to discuss the old operation, and, in answer to the objection that, though the Hunterian operation has been attended with "awful mortality" here, we are not made more secure by operating on an artery, perhaps not much more than 3 inches lower down, and already involved in disease, writes: "I reply, that if we grant the artery where it is involved in the sac to be healthy enough to bear the ligature, many advantages may be found in the old operation over that of Hunter. . . . . First, the clot is removed, and the sac laid open; consequently, that softening of clot and inflammation of a closed sac lying in proximity to the peritonæum, which is so surely fatal, is obviated. Next, the ligature will probably be placed on the external iliac instead of the common, and thus the chances of gangrene will be greatly diminished, since the internal iliac and its branches are left open. Thirdly, the artery is tied at a point where most likely the peritonæum and viscera have been pushed away from it by the sac, so that there is less risk of hurtful interference with these latter in the operation. And, lastly, the total excision of the tumour precludes any such relapse as occurs sometimes after the Hunterian operation.

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* *Trans. Amer. Surg. Assoc.*, vol. i. p. 234. Sixty-seven cases are given, but the result is not stated in two.

† Grouping these cases into classes, after Dr. Smith's example, in order to obtain more satisfactory deductions, Dr. Packard concludes as follows:—(i) Those cases in which the operation was done for the arrest of hæmorrhage: 22 cases, of which 19 died and 3 recovered; mortality, 86.36 per cent. (ii) Those in which it was done for the cure of aneurism: 35 cases, of which 24 died and 9 recovered, the result not being stated in 2; mortality in 33 cases, 72.72 per cent. (iii) Those cases in which tumours simulating aneurism led to its performance: 5 cases, 4 of which died and 1 recovered. (iv) Those in which the vessel was secured to prevent hæmorrhage during the removal of a morbid growth: 3 cases, all of which died.

"Against these advantages must be set the undoubted risks of secondary hæmorrhage, even in cases where the immediate dangers of the operation have been surmounted. What this risk is we have no means of judging until our experience of this operation becomes greater; but I am under the impression that Mr. Syme much underrated it, in consequence of having operated chiefly upon traumatic aneurism."

Farther on, Mr. Holmes writes, while "maintaining that the old doctrine on which the superiority of Hunter's operation is based is quite true in general, I should have no objection in the particular instance of iliac aneurism to follow Mr. Syme's practice; at least, until further experience of it should show that it is wrong: only the less dangerous expedient of rapid compression of the trunk artery under chloroform, or gradual compression, with or without chloroform, should first be tried."

The same authority, when, later on, discussing the value of pressure, brings out the following facts. That, while rapid compression under chloroform is a mode of treatment by which most gratifying success has been obtained in iliac as well as aortic aneurism, it exposes the patient to serious dangers. Amongst these are enteritis and peritonitis from bruising of small intestine, mesentery, meso-colon, and sympathetic; hæmaturia; failure of pulse and breathing when the pad is screwed down. On account of these very real dangers, which every dexterity may not obviate, Mr. Holmes advocates a trial of gradual compression, as safer, though less efficient, and he points out that the relations of the common iliac are less complicated than those of the aorta, and, "as we get further to one side, there is more chance for the intestines to slip out of the way."[*]

2. Wounds. These may be gunshot or bayonet wounds, or knife stabs of the vessel itself, or the internal iliac or its branches, usually the latter. The hæmorrhage calling for ligature seems to be usually secondary.[†] Gunshot wounds of the common iliac

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[*] Mr. Holmes draws attention also to this most important point—*i.e.*, that rapid coagulation in an aneurismal tumour cannot be regarded as in itself a means of cure, but only as the commencement of a process which, if not interrupted, may result in cure, and that thus, while pulsation may diminish soon after a trial of compression, it may not absolutely cease for quite a month.

[†] It would naturally be thought that hæmorrhage from a wound of the common iliac would be fatal before a ligature could be applied. Dr. Otis gives a case in

have a fresh interest now, owing to the recent advances in surgery in the treatment of gunshot wounds of the abdomen.

Dr. S. Smith* gives two cases of ligature of the common iliac for wounds, one from a musket-ball which injured the vessel itself, passed through the intestines, and lodged in the sacrum. The operation was performed by opening the peritonæal cavity. Peritonitis soon set in; secondary hæmorrhage recurred repeatedly, and the case ended fatally on the fifteenth day. The other case is of great interest, as the common and internal iliac were here tied for severe hæmorrhage after a stab in the inguinal region. A large quantity of blood was found in the peritonæal cavity, and the patient died ten hours after the operation. At the autopsy it was found that the deep epigastric was the wounded vessel.

Dr. Otis† records four cases of ligature of the common iliac during the American Civil War. In one, a gunshot wound, in which the ball entered the groin and came out at the buttock, the external iliac was first tied, the repeated hæmorrhages being believed to be from the profunda, but as the bleeding persisted and evidently came from the sciatic, the wound was prolonged and the common iliac tied. Both ligatures came away, and the operation-wound healed, but the patient died about three months later of exhaustion, associated, apparently, with necrosis in the gluteal region. In the second case the common iliac was tied for a gunshot wound believed to be of the gluteal artery, in which the hæmorrhage was not arrested by tying the internal iliac. The hæmorrhage recurred, and death took place two days later. The third case was one of diffuse aneurism of the right buttock and iliac fossa resulting from a bayonet stab in the former region. Death took place four days later from gangrene of the sac. The old operation is considered by Dr. Otis to have been preferable in this case, but as the post-mortem showed that the anterior trunk of the internal iliac had been wounded, within the sacro-sciatic notch, by the bayonet, it is difficult to see how the case could have been treated save by ligature of the internal iliac, either outside or within the peritonæum, and then by opening and filling the aneurismal sac with aseptic gauze or sponges. The fourth case was one of aneurismal varix of the femoral vessels from a punc-

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which this vessel was wounded by a ball entering from the buttock through the sacro-iliac synchondrosis. Death took place from hæmorrhage on the second day.

[*] *Amer. Journ. Med. Sci.*, 1860, vol. xl. p. 17.

[†] *Med. and Surg. Hist. of the War of the Rebellion*, pt. ii. p. 333.

tured wound 2 inches below Poupart's ligament. In this case, owing to the impossibility of separating the peritonæum, this was incised and the common iliac thus secured. Peritonitis proved fatal four days later. Here ligature of the artery lower down, above and below the original seat of injury, would have been better treatment.

3. For the arrest of hæmorrhage apart from aneurism. Such cases may be met with after amputation near the hip, followed by secondary hæmorrhage from the branches of the internal iliac in what is usually the posterior flap.

Mr. Liston* published a case of this kind in which, after amputation below the trochanter minor for necrosis of the femur, hæmorrhage occurred from the stump on the seventh day. As this could not be arrested the common iliac was tied, but the patient died twenty-four hours later.

Dr. Packard† treated a somewhat similar case in the same way, successfully. This case is especially interesting, as the hæmorrhage occurred from branches of the internal iliac after a Furneaux Jordan's amputation, a method which is coming largely into vogue now, and which would usually be expected to do away with the above risk.‡ Hæmorrhage occurred from the stump on the sixth day, and as pressure failed the common iliac was tied. The patient ultimately did well.

It will not, it is hoped, seem a hasty criticism on the above if I say that in future cases opening up the flaps and plugging with aseptic gauze,§ or the application for some days of Spencer Wells' forceps, aided by even pressure on the flaps and pressure on the common or external iliac, would be preferable to submitting the patient here to the severe and risky operation of ligature of the common iliac.

4. For pulsating tumours simulating aneurism. As these growths from the iliac fossa and the walls of the pelvis have been found to be malignant, it is of the utmost importance to form a correct diagnosis in these cases, and thus save a patient who has a certainly fatal disorder from being submitted to an operation which is most dangerous, and almost certain to be useless.‖ As

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* *Lond. Med. Gaz.*, April 24, 1830. † *Loc. supra cit.*, foot-note, p. 618.

‡ In Dr. Packard's case the Furneaux Jordan's amputation was performed probably higher up than usual, owing to osteo-myelitis, after a previous amputation for growth, at about the middle of the thigh.

§ The gauze within the wound being wrung out of turpentine if the parts are sloughy (p. 481).

‖ In Guthrie's case, a pulsating tumour in the right buttock, the size of an mistakes have, however, been made in these cases by excellent surgeons,* the chief points of diagnosis, as given by Mr. Holmes,† may be briefly mentioned here: (1) The bruit is usually less well marked; (2) The pulsation is less heaving and less expansive; (3) The condition of the bone with which the swelling is connected; thus, a plate of bone may be found in the supposed aneurismal sac; the supposed aneurism may be found both on the gluteal and the iliac aspects of the pelvis, the bone being expanded by the growth; (4) The cancerous cachexia is usually present, and perhaps secondary growths as well.

5. For hæmorrhage, not the result of a wound. Ligature of the common iliac has been employed in some cases of this nature, usually secondary hæmorrhage after ligature of the external iliac, the gluteal and sciatic, or after rupture of the external iliac. Ligature of the main trunk has been so fatal there that it should be abandoned, carefully applied pressure aided by plugging with aseptic gauze, or the old operation being certainly preferable.

Mr. Morrant Baker has put on record ‡ a case of great interest in diagnosis, in which an abscess from sacro-iliac disease ulcerated into branches of the internal iliac artery, and when opened gave rise to hæmorrhage calling for ligature of the common iliac:—A gardener, aged seventeen, had felt pain a month previously while digging. A tense, elastic swelling, distinctly fluctuating, and acutely tender, occupied all the right buttock. It was opened, and a small stream of apparently arterial blood escaped without jets. On further exploration the finger entered a large cavity between the iliac bone and the glutei. The iliac fossa was full and tense, and on examination, per rectum, a swelling was found in the right ischio-rectal fossa. On enlarging the gluteal wound a steady stream of arterial blood welled up through the great sacro-sciatic foramen. This was firmly plugged, and the common iliac tied. On removing the plug some bleeding still occurred, but was easily arrested. The gluteal wound became offensive, and this region, together with the upper part of the thigh, became

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adult head, diminished by one-half in a month. Two months later it again enlarged, and the patient dying, eight months after the operation, an immense encephaloid tumour was found occupying the right iliac region.

* *E.g.*, Guthrie (*Lond. Med. Gaz.*, vol. ii. 1834); Stanley (*Med. Chir. Trans.*, vol. xxviii.); Moore (*ibid.*, vol. xxxv.).

† *Syst. of Surg.*, vol. iii. pp. 44, 145. The reader should also consult Mr. Holmes's article, "On Pulsating Tumours which are not Aneurismal, and on Aneurisms which are not Pulsating Tumours" (*St. George's Hosp. Reports*, vol. vii.).

‡ *St. Barthol. Hosp. Reps.*, vol. viii. p. 120.

gangrenous, the leg and foot remaining unaffected. The patient died forty hours after the operation.

Post mortem the sacro-iliac joint was open with surrounding caries. The remains of a large abscess was found involving the branches of the internal iliac. There was no trace of aneurism.

6. Preparatory to removal of caries of the pelvis. Where, after amputation at the hip-joint, pelvic caries persists, leading steadily to lardaceous disease, I think an attempt should be made to remove all of the innominate bone which is diseased. Such profuse oozing follows that the common iliac should first be tied. I adopted this course in a boy aged nine three years ago. The common iliac was most easily tied by the free anterior abdominal incision given below, and the pubic part of the bone removed the same day. A little later I removed the ischium and the acetabular portion of the ilium, leaving the upper half. Bronchitis, increased, I fear, by the ether given at the second operation, carried off the child three weeks after ligature of the common iliac. The bleeding was slight and easily arrested, the chief difficulty met with here being the detachment of the soft parts in the neighbourhood of the pubes, tuber ischii, and sacro-iliac joint. The thickening of the pelvic fascia, present in these advanced cases, shuts off the contents of the pelvis.

Surgical Anatomy.—The common iliacs coming off on the left side of the fourth lumbar vertebra, incline downwards and outwards to divide, opposite to the lumbo-sacral intervertebral disc, into the internal and external iliacs. The right is rather the longer and more oblique of the two. Their length is usually 1½ inch. Their branches are few and small—viz., to the ureter, psoas muscles, glands, &c. The iliacs become increasingly tortuous with age: a point of importance in tying the vessel on an aged corpse.

LINE.—One drawn from a point 1½ inch below and a little to the left of the umbilicus to the centre of Poupart's ligament, the line curving a little outwards in its course, will represent the course of the artery with sufficient accuracy.

GUIDE.—The above line is the only surface guide: more deeply the lumbo-sacral articulation and the psoas muscles are useful guides, especially in a thin subject.*

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* Attention has been drawn to the need of employing touch, as well as sight, in the ligature of these large trunks (p. 612).

RELATIONS :—

IN FRONT.

Peritonæum ; small intestine ; cæcum and appendix, sometimes.
Ureter.
Sympathetic.

OUTSIDE.

Psoas.
Vena cava.
Right common iliac vein.

INSIDE.

Left common iliac vein.

Right common iliac artery.

BEHIND.

Right and left common iliac vein.

IN FRONT.

Peritonæum ; small intestine.
Sympathetic.
Ureter.
Superior hæmorrhoidal artery.

Rectum.

OUTSIDE.

Psoas.

Left common iliac artery.

BEHIND.

Left common iliac vein.

Collateral Circulation.—The chief vessels are :—

ABOVE.		BELOW.
Internal mammary and lower intercostals,	with	Deep epigastric.
Lumbar,	with	Ilio-lumbar and circumflex iliac.
Middle sacral,	with	Lateral sacral.
Superior hæmorrhoidal,	with	Inferior and middle hæmorrhoidal.

In addition, the pubic arteries anastomose behind the symphysis.

Operations (Fig. 107).—The common iliac may be tied by operations based upon one of two incisions. (1) An anterior abdominal by which the vessel is approached more directly from the front; an incision based upon those for tying the external iliac, and made use of by Dr. Mott, of New York, who first tied this vessel for aneurism in 1827. (2) A posterior abdominal, or loin incision, by which the vessel is reached from behind; a method made use of by Sir P. Crampton, of Dublin, in 1828, and by Mr. Stanley at St. Bartholomew's, in 1846 (Fig. 107).

(1) *Anterior Abdominal Incision.*—The preparatory treatment is here the same as that for the external iliac. The parts being shaved and cleansed, a curved incision, 5 to 8 inches long, according to the amount of fat, the development of the body, and the size of the aneurism, is made, commencing just outside the centre of Poupart's ligament and 1½ inch above it, then carried outwards, reaching towards the crest of the ilium, then upwards towards the ribs, and finally curving inwards towards the umbilicus, till sufficiently free to admit of the necessary manipulations for reaching the artery. The three abdominal muscles are cut through, either on a director, or with careful light sweeps of the knife, till the fascia transversalis is reached; any vessels which bleed* being at once secured with Spencer Wells' forceps. The fascia transversalis, which may generally be known from the peritonæum by the layer of extra-peritonæal fat, which usually intervenes between the two, is then picked up and divided on a director, at the lower part of the wound where it is best marked.† The peritonæum is next raised upwards and inwards, first one finger, and then more, being insinuated towards the middle line until the psoas is reached. On the inner side of this muscle the artery will be found, the external iliac being traced up if needful. In order to aid the surgeon in the difficulties which are now met with, owing to the artery lying at the bottom of a very deep wound, the abdominal walls should be relaxed by bending up the thighs, the wound sponged thoroughly dry, and light thrown in by a reflector if needful. Care will, of course, have been taken to divide every layer from end to end equally, and thus to avoid a conical hole of a wound. The position of the vessel having been made out, it is to be cleaned with a director, especial care being taken on the right side, as here both the common iliac veins lie behind the artery. The needle should be passed from within outwards.

(2) *Posterior Incision, partly in Abdomen, partly in Loin.*—This operation will be best given in the words of Sir P. Crampton,‡ who first introduced it:

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* See note, p. 611.

† Dr. Liddell (*Intern. Encycl. of Surg.*, vol. iii. p. 312) recommends that the separation of this fascia from the peritonæum should be begun at the upper part of the wound, where the adhesion is slightest.

‡ *Med. Chir. Trans.*, vol. xvi. p. 161.

"The first incision * commenced at the anterior extremity of the last false rib, proceeding directly downwards to the ilium; it followed the line of the crista ilii, keeping a very little within its inner margin, until it terminated at the superior anterior spinous process of that bone; the incision was therefore chiefly curvilinear, the concavity looking towards the navel. The abdominal muscles were then divided to the extent of about an inch, close to the superior anterior spinous process, down to the peritonæum; into this wound the forefinger of the left hand was introduced, and passed slowly and cautiously along the line of the crista ilii, separating the peritonæum from the fascia iliaca. A probe-pointed bistoury was now passed along the finger to its extremity, and by raising the heel of the knife, while its point rested firmly at the end of the finger as on a fulcrum, the abdominal muscles were separated from their attachments to the crista ilii by a single stroke. By repeating this manœuvre the wound was prolonged until sufficient room was obtained to pass down the hand between the peritonæum and the fascia iliaca. Detaching the very slight connections which these parts have with each other, I was able to raise up the peritonæal sac, with its contained intestines, on the palm of my hand from the psoas magnus and iliacus internus muscles, and thus obtain a distinct view of all the important parts beneath; and assuredly a more striking view has seldom been presented to the eye of the surgeon; the parts were unobscured by a single drop of blood; there lay the great iliac artery, nearly as large as my finger, beating awfully, at the rate of 120 in a minute, its yellowish-white coat contrasting strongly with the dark blue of the iliac vein which lay beside it, and seemed nearly double its size, the ureter in its course to the bladder lay like a white tape across the artery, but in the process of separating the peritonæum, it was raised from it with that membrane to which it remained attached. The fulness of the iliac vein seemed to vary from time to time, now appearing to rise above the level of the artery, and now to subside below it. Nothing could be more easy than to pass a ligature round an artery so situated. The forefinger of the left hand was passed under the artery, which, with a little management, was easily separated from the vein; and on the finger (which served as a guide) a common-eyed probe, furnished with a ligature of moistened catgut, was passed under the vessel. A surgeon's knot was made in the ligature, and the noose gradually closed, until Mr. Colles, who held

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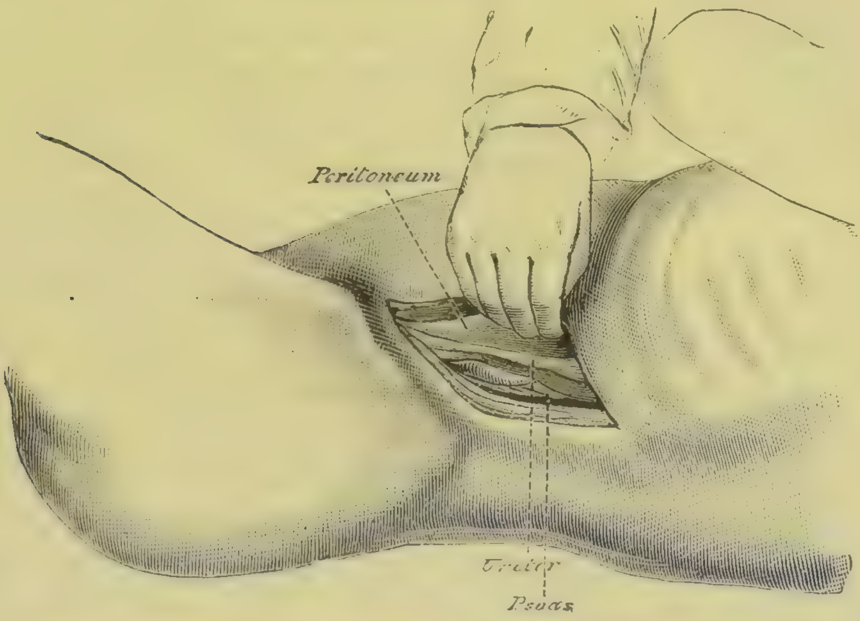
* The patient would, of course, be rolled over on to the sound side.

his hand pressed upon the tumour, announced that all pulsation had ceased. A second knot was then made, and one end of the ligature cut off short." Unfortunately, the catgut of that day became quickly dissolved, pulsation returned in the tumour within fifty hours of the operation, and on the tenth day profuse secondary hæmorrhage took place, death following immediately.

FIG. 107.



Ligature of common iliac by a posterior incision. This would also be available for the abdominal aorta. (Bryant.)

Comparison of the Two Methods.—Sir P. Crampton thus speaks of his own and Dr. Mott's operation: "The operation of tying the common iliac artery is not only a feasible but (when performed in the manner described in this paper) an exceedingly easy operation. The difficulties which Dr. Mott encountered, and which prolonged the operation to nearly an hour,* are clearly referable to the circumstance of his incision having been made too low. This, in the first place, brought him in contact with the aneurismal tumour, from which he was obliged, with great labour and considerable risk, to detach the peritonæum; then he had the whole mass of the tumour between him and the artery which he was to tie; and, lastly, he had the intestines pressing down upon him and producing such a complication of difficulties as I believe few men but himself could have encountered with success."

Mr. Skey (*Operative Surgery*, p. 294) preferred the posterior incision for these reasons: (1) It is a part less liable to consequent inflammation. (2) The requisite separation of the peritonæum is less extensive. (3) The artery is brought better into view, the act of passing the needle round it being made visible to observers around. (4) The line of the vessel is sufficiently exposed to enable the operator to select his site of ligature, to carry it either higher or lower, or even, if necessary, to separate the peritonæum from the aorta itself, and to pass a ligature around that vessel at a sufficient distance from its bifurcation. (5) The formation of a ventral hernia is not likely to occur.

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* Sir P. Crampton's operation was completed in twenty-two minutes.

To the above Mr. Skey might have added that the posterior incision gives far better drainage to the wound.

The difficulties of the operation and the causes of failure and of death are much the same as those already given in the account of ligature of the external iliac (pp. 614, 615).

LIGATURE OF THE INTERNAL ILIAC.

Indications.—Very few and rare.

i. In some cases of gluteal and sciatic aneurisms. Mr. Holmes in the course of those lectures from which I have already quoted, lays down conclusions which will very greatly help the surgeon in deciding what form of treatment is best suited to these aneurisms. They are quoted below under the heading of Ligature of the Gluteal Artery (p. 632).

ii. Hæmorrhage. This is most frequently met with in military surgery after gun-shot wounds of the vessel itself, but more often of one or more of its branches within the pelvis, the ball entering usually from the front through the inguinal region, or behind through the sacrum. Four such cases are given by Dr. Otis,* all being fatal. Two cases, in which this artery was tied for wounds of the sciatic and gluteal respectively, are given by the above writer (p. 332); both were fatal from hæmorrhage.

Dr. Liddell,† who, as U.S.A. Medical Inspector, saw much of military surgery, gives the following advice in cases of punctured wounds of this artery or its branches: "The wound should be explored by introducing the finger into it for the purpose of locating by touch the precise point whence the blood issues by jets into the wound. If the punctured artery is found to be external to the pelvis, the bleeding point should be laid bare by enlarging and cleansing the wound, and the vessel secured by ligatures placed on each side of the aperture. But if it be shown by the occurrence of intra-pelvic extravasation of blood, or by other signs, that the internal iliac artery, or some branch thereof, is wounded within the pelvis, it will be impossible to reach and tie the punctured artery in the wound. Under these circumstances it sometimes becomes very difficult to decide what plan of treatment should be adopted. . . . . One thing," Dr. Liddell goes on to say, "ought never to be done, that is, trusting to the use of iron perchloride or persulphate. The first thing to be tried, in most cases, is compression. It should be applied to the common iliac artery, and, at the same time, to the wound itself, if possible, with a view to obtain coagulation of the blood in, and obliteration of, the wounded artery. The very desperateness of these cases makes it all the more necessary to use the compression faithfully, intelligently, and persistently, otherwise a traumatic aneurism will form." Nowadays, laparotomy will very likely be resorted to (p. 630).

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* *Med. and Surg. History of the War of the Rebellion*, pt. ii. p. 331.

† *Intern. Encycl. of Surg.*, vol. iii. p. 125.

Surgical Anatomy.—A short trunk, about 1½ inch long, of large size, the internal iliac, given off opposite to the lumbo-sacral intervertebral disc, dips downwards and backwards as far as the upper part of the sacro-sciatic notch, where it gives off its anterior and posterior trunks, a ligamentous cord also coming off from the bifurcation: this cord, the remains of the obliterated hypogastric artery, usually remains pervious as far as the bladder as one of the vesical arteries.

LINE.—No distinct line or guide can be given for this vessel owing to its at once dipping into the pelvis, but it will be worth while to remember that a line drawn with a slight curve outwards from a point about an inch below, and a little to the left of, the umbilicus, to the centre of Poupart's ligament, gives sufficiently accurately the line of the common and external iliac arteries: the internal is given off about two inches from the commencement of this line.*

RELATIONS:—

IN FRONT.
Ureter.
Peritonæum.
Rectum (left side).

OUTSIDE.
Right internal iliac vein.
Obturator nerve.

Internal iliac.

INSIDE.
Pyriformis.
Sacral nerves.

BEHIND.
Internal iliac vein.
Sacro-iliac synchondrosis.
Lumbo-sacral nerve.

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* The origin of the arteries will be found nearly opposite to the centre of a line drawn from the anterior superior spine to the umbilicus.

Operation.—The preparatory treatment being the same as in ligature of the external iliac (p. 611), the surgeon makes an incision much as in the case of that artery, or else, in the words of Dr. Stevens (who first tied the vessel successfully in 1812), "one about 5 inches long, parallel with the deep epigastric artery, and nearly $\frac{1}{2}$ inch on the outer side of it." The peritonæum having being raised up, the hips are well flexed, and the lips of the wound retracted as widely as possible: the finger now finds the external iliac, and then, by tracing it up, the internal iliac vessel.* The cord of the obturator nerve must not be mistaken for this.†

The artery is now separated, partly with the finger-nail and partly with the point of the director, and the needle passed from within outwards, avoiding the vein and psoas muscle. It will be well to have in readiness aneurism needles of different curves, and an ordinary silver-eyed probe.

Ligature of the Internal Iliac by Laparotomy.—This method has been advocated recently by Dr. Dennis,‡ of New York, on account of the following advantages:—(1) Laparotomy in no way increases the dangers of the operation of ligature of the internal iliac. (2) Laparotomy prevents a series of accidents which have occurred during the performance of the operation of ligature of this artery by the older methods. Amongst these are, the division of the circumflex and epigastric arteries, wounding the vas deferens, including the ureter in the ligature, puncturing the iliac or circumflex veins, tying the genital branch of the genito-crural, tearing the peritonæum, injury to the sub-peritonæal connective tissue, cellulitis, purulent œdema, pelvic abscess, septicæmia, and pyæmia. (3) Laparotomy enables the surgeon to apply the ligature at a point of election, and to obtain information as to the exact extent of disease in the main arterial trunk. (4) Securing the internal iliac by laparotomy takes much less time than was occupied by the older methods.

Three cases are given by Dr. Dennis, two of which occurred in his own practice. (A) A woman, aged sixty, presented pulsatile tumours in both gluteal regions, the tumours dating back a year and a half, and pain three years back. The external parts being thoroughly purified, a median incision was made from the umbilicus to the pubes; the small intestines, which would have hindered the operation, were drawn out into warm, moist sponges and towels, the internal iliacs of both sides ligatured with catgut, the viscera returned, the wound closed, and aseptic dressing supplied. The patient died with suppression of urine, and slight parenchymatous nephritis, on the third day. (B) A negro, aged forty-six, had a right gluteal aneurism, the trouble dating back seven months. By a curved lateral incision the abdomen was opened; owing to the violent efforts of the patient, and the difficulty of manipulation, a few coils of intestine were drawn out, a strong silk ligature applied to the internal iliac, the parts cleansed, and the wound closed. A cure followed. (C) A female, aged eighteen, had an aneurismal varix of the left side, the trouble dating back many years. Under careful antiseptic treatment the abdomen was opened, the incision finally extending from the symphysis to some distance above the umbilicus, the intestines drawn out sufficiently to admit of exposure of the vessel, a double twisted catgut ligature applied to the left internal iliac, the bowels returned, and the wound treated as before. The patient rallied quickly, and the bowels were moved normally on the fifth day: a slight acute albuminuria, due to congestion of the kidney from the ligature of the main trunk of the internal iliac, appeared on the following day, but soon disappeared. The aneurism, together with the aneurismal varix, was perfectly cured.

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* The finger should be passed downwards and backwards towards the sacro-iliac synchondrosis.

† In cases of doubt the artery should be compressed gently between the finger and thumb.

‡ *New York Med. News*, November 20, 1886; *Annals of Surgery*, vol. v. No. 1, p. 55. I am indebted to the latter periodical for the above account.

LIGATURE OF THE GLUTEAL ARTERY.

Indications.

1. Stab. 2. Aneurism. 3. Hæmorrhage after opening an abscess. All are rare, especially the last.

1. Stab.—The source of the bleeding from a stab in the buttock may be very difficult to tell exactly. The surgeon must be guided by the position of the exit of the gluteal and sciatic (pp. 633, 635); he will remember the outline of the gluteus maximus, the lower border of this muscle forming the fold of the buttock, the upper starting from the crest about 2 inches in front of the posterior superior spine, and running downwards and forwards to the great trochanter. Hæmorrhage from a stab in the upper part of this muscle will probably come from the gluteal; if from the lower part, from the gluteal or sciatic.

2. Aneurism.—This affection is so rare that it will be sufficient to quote the following conclusions of Mr. Holmes:*—

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* Hunt. Lect., *Lancet*, 1874, vol. ii. p. 76; *Syst. of Surg.*, vol. iii. p. 148.

(1) "Gluteal aneurisms, both traumatic and spontaneous, are very favourably circumstanced for the treatment by either rapid or gradual compression applied to the aorta or common iliac." Mr. Holmes points out that gluteal aneurism, if not ruptured, is usually of no great size, and does not encroach upon the abdomen, and thus any part of the common iliac or aorta is accessible to pressure.

(2) "If this treatment, with or without anæsthetics, does not succeed by itself, it may be supplemented by coagulating injection or galvano-puncture, while the patient is narcotized, and the circulation commanded." Of the two, Mr. Holmes prefers galvano-puncture.*

(3) "When such treatment fails, and particularly in aneurisms with imperfect or ruptured sacs, where it is not indicated, the internal iliac must be tied when the surgeon thinks that he cannot find the artery outside the pelvis. But when the artery is accessible, the old operation, or the operation of Anel, should be practised, according to the size and extent of the tumour."

In deciding whether the aneurism is inside or outside the pelvis, the surgeon will see if the pulsation can be commanded by pressure on the artery above the aneurism, whether the latter can be lifted from the bone, and will also make an examination by vagina or rectum.†

The old operation must always be formidable, and while modern tourniquets may admit of efficient pressure, there is always the risk of fatal hæmorrhage from the artery having retracted into the pelvis.

The method of Anel does not seem likely to be often useful: of three cases, one only has been successful.

(4) "The ligature of the internal iliac is liable to failure in cases of spontaneous aneurism from a diseased condition of the coats of the artery, and should always be avoided when other means of treatment are available."

This method has proved fatal in about half the cases operated on. The varying length of the artery, the proximity of the ligature in all cases to large branches and to the sac, have all to be remembered.

Here also ligature of the artery by laparotomy will probably be resorted to in the future.

Surgical Anatomy of Gluteal Artery.—A short, thick branch

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[*] See the remarks on the introduction of foreign bodies and galvano-puncture, pp. 565, 567.

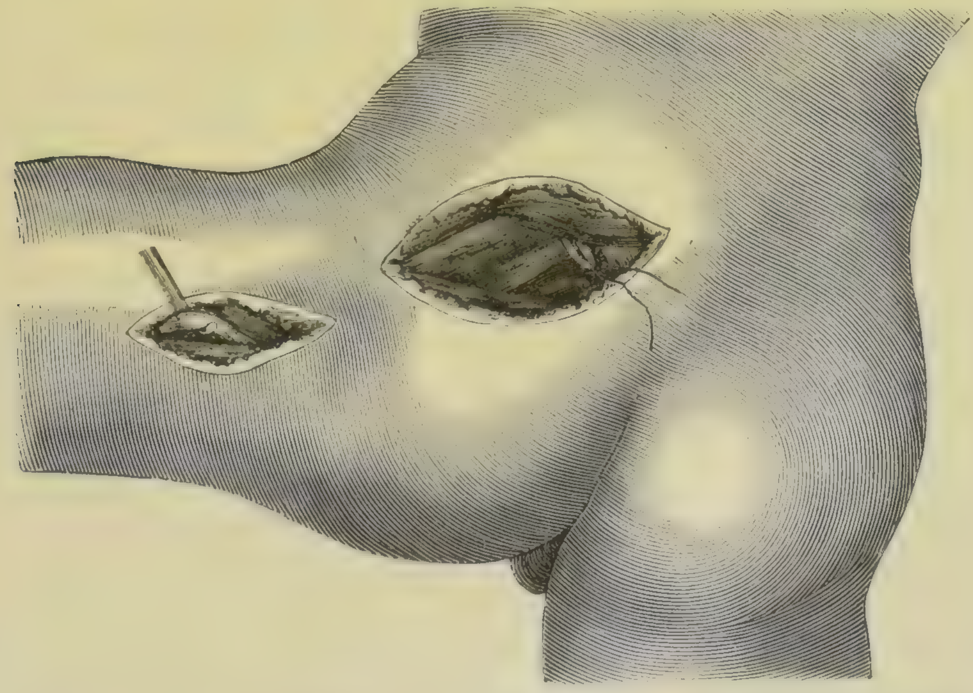
[†] An anæsthetic being given, and the hand passed here, if needful.

from the posterior division of the internal iliac, this leaves the pelvis above the pyriformis, through the sacro-sciatic notch. Immediately after its exit it divides into a superficial and deep portion. The superficial is mainly distributed to the gluteus maximus; the deep lies between the gluteus medius and minimus, and divides into two, the upper branch running along the origin of the gluteus minimus, and the lower running obliquely across this muscle towards the trochanter major. The gluteal nerve emerges just below its artery, and sends branches with the deeper portion.

Line and Guide.—"If a line be drawn from the posterior superior spine to the great trochanter, the limb being slightly flexed and rotated inwards, the point of emergence of the gluteal artery from the upper part of the sciatic notch will correspond with the junction of the upper with the middle third of this line" (MacCormac, *Lig. of Arts*, p. 126, figs. 90, 91).

Operation.—The patient being rolled two-thirds over on to his face, the part well exposed and cleansed, the limb hanging over the edge of the table, an incision, 5 inches long, is made in a line running from the posterior superior spine to the upper and inner part of the great trochanter. This incision should run almost

Fig. 108.



Ligature of the gluteal artery is shown above. The fibres of the gluteus maximus have been separated, showing the medius beneath. The vessel has been secured close to the great sacro-sciatic notch, before it divides into a superficial and deep part. The latter is not shown. Below is shown the incision for stretching the great sciatic nerve, as it lies under cover of the ham-strings.

parallel with the gluteus maximus. The fibres of this muscle being separated, between adjacent fasciculi, with a director, a muscular branch should be found and traced down to the exit of the artery. The gluteus maximus having been relaxed, and the contiguous margins of the gluteus medius and pyriformis separated with retractors, the surgeon, taking as his guide the above line and the aperture of the great sacro-sciatic notch, clears the artery as high up as possible, avoiding the nerve and the veins, and dividing the adjacent muscles if needful. The ligature should be applied as far within the notch as possible, almost within the pelvis, as the gluteal divides immediately after its exit.

Old Operation.—The following is the account of Prof. Syme's case. The man had been stabbed in the buttock seven years before. The aneurism measured more than 13 inches in both diameters; this, together with the great thinness and laxity of the coverings being opposed to coagulation, led to the adoption of the old operation. "The patient having been rendered unconscious and placed on his right side, I thrust a bistoury into the tumour, over the situation of the gluteal artery, and introduced my finger so as to prevent the blood from flowing except by occasional gushes, which showed what would have been the effect of neglecting this precaution, while I searched for the vessel. Finding it impossible to accomplish the object in this way, I enlarged the wound sufficiently for the introduction of my fingers in succession, until the whole hand was admitted into the cavity, of which the orifice was still so small as to embrace the wrist with a tightness that prevented any continuous hæmorrhage. Being now able to explore the state of things satisfactorily, I found that there was a large mass of dense fibrinous coagulum firmly impacted into the sciatic notch, and, not without using considerable force, succeeded in disengaging the whole of this obstacle to reaching the artery. . . . . The gentlemen who assisted me being prepared for the next step of the process, I ran my knife rapidly through the whole extent of the tumour, turned out all that was within it, and had the bleeding orifice instantly under subjection by the pressure of a finger. Nothing then remained but to pass a double thread under the vessel and tie it on both sides of the aperture." The case did perfectly well * (*Obs. in Clin. Surg.*, p. 169).

If, in the case of a stab, the hæmorrhage continue after the ligature has been applied with the above precautions, and the gluteal has evidently been punctured within the pelvis, the internal iliac must be tied after the wound in the buttock has been firmly plugged with dry gauze, or boric lint and iodoform.

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* Nowadays, the application of a Lister's tourniquet to the abdominal aorta would facilitate matters. Another successful case is recorded by Mr. J. Bell (*Prin. of Surg.*, vol. i. p. 1801).

LIGATURE OF THE SCIATIC ARTERY.

Indications.—Stab. This operation is so very rarely required that it may be very briefly described here.

Surgical Anatomy.—The sciatic artery emerges, together with the sciatic nerve and the pudic artery, from the lower part of the great sacro-sciatic notch below the pyriformis.

GUIDE AND LINE.—The limb being rotated inwards, a line is drawn from the posterior superior spine to the ischial tuberosity. The exit of the sciatic and pudic arteries corresponds to the junction of the middle and lower thirds of this line.

Operation.—The sciatic artery may be found by one of two incisions, (*a*) by a horizontal one, about 5 inches long, made about 1½ inch below that for the gluteal artery, and, like that, parallel with the fibres of the gluteus maximus. (*b*) By one made vertically in the above given line. The deeper guides will be the margins of the notches, or the great sciatic nerve. The intra-peritonæal method will facilitate exposure of the vessel.

LIGATURE OF THE ABDOMINAL AORTA.

Indications.—As this most rare operation has been fatal in every one of the cases in which it has been performed (some nine or ten*), its justifiability has naturally been called in question. On the one hand, the desperate condition of the patients, the large amount of disease probably present in their arteries, hearts, &c., the large and rapid blood-current, the disturbance of very vital parts, and the risk of peritonitis, all combine to render the probability of success extremely small. On the other hand, recent improvements in surgery, the introduction of better ligatures, the fact that in these cases life must speedily end if nothing is done, and, perhaps, the fact that many of the large operations of surgery have been unsuccessful at first, will justify surgeons in again making trial of this forlorn hope, if they feel certain that otherwise the case is quite hopeless.

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* In Erichsen's *Surgery* (vol. ii. p. 237) seven cases are given, but this list does not contain either Dr. P. H. Watson's case nor the two of Czerny, though one of these is mentioned later.

The cases have mostly been those of iliac and inguinal aneurism, in which other arteries have been tied without success. To justify the epithet above given of "desperate," the first case, the well-known one of Sir A. Cooper (in 1817),* may be alluded to. Here the patient had long suffered from an aneurism affecting the external and common iliac arteries, leading to sloughing of the skin and hæmorrhage. Sir Astley having failed in an attempt to perform the old operation, owing to the artery lying so deeply, gave the patient "the only hope of safety" which remained, by tying the aorta. As life was here prolonged for forty hours, and as in Montiero's case death did not take place till the tenth day, proof is given of the restoration of the collateral circulation. As bearing on this point the words of Sir A. Cooper are of great interest: "I knew that the aorta had been obliterated within the chest, and that the circulation had been carried on by the intercostal arteries going from above to just below the spot where the aorta was obliterated; the insides of the ribs are covered with numerous vessels. A gentleman of Dublin had a preparation in which the aorta had been obliterated in the abdomen, and in this case the circulation was carried on by the lumbar arteries going from above to below the part where the vessel was obliterated."†

In addition to the above cases, in which the aorta has been tied in cases of aneurism, it has been tied once for hæmorrhage after a gun-shot injury of the upper part of the thigh by Czerny of Heidelberg. Hæmorrhage continuing, the common femoral was tied, together with the superficial femoral below the profunda. Bleeding taking place again in six days, the common iliac was tied. The hæmorrhage still persisting, it was thought that the external iliac only had been tied, and a ligature was next placed, by mistake, upon the aorta. The patient lived twenty-six hours. The same surgeon during a nephrectomy for a soft malignant growth of the kidney met with such uncontrollable hæmorrhage as to compel him to tie the aorta, the patient dying soon after.

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* *Prin. and Pract. of Surg.* (edited by Dr. Lee), vol. i. p. 228.

† In comparing these instances of the restoration of the circulation, the one by disease and the other after the surgeon's ligature, the importance of the slow and gradual process in the one case will not be lost sight of. Mr. Barwell (*Intern. Encycl. of Surg.*, vol. iii. p. 481) alludes to the experiments of Pirogoff (Waller and von Gräfe's *Journ.*, Bd. xxvii. s. 122) and a paper by Kast (*Zeit. f. Chir.*, Bd. xii. s. 405) to show that the collateral circulation is established. Sir A. Cooper (*loc. supra cit.*) used to show in his lectures an injected specimen from a dog which survived the operation. Beyond this fact, however, no comparison can be made between the chance of survival of healthy animals and that of patients reduced to such straits as to call for this operation.

Surgical Anatomy.—The lowest part of the aorta—viz., that between the bifurcation and the origin of the inferior mesenteric—is that which should be chosen.*

The vessel may have in front of it the omentum, duodenum, mesentery, small intestines, and more closely, the aortic plexus of the sympathetic, and a layer of fascia of various strength. To the right side lies the vena cava, and behind it are the left lumbar veins. The bifurcation is usually situated a little to the left side of the umbilicus and about $\frac{3}{4}$ inch below it.

Operation.—This may be performed (A) through, or (B) behind, the peritonæum. In deciding which method to make use of the surgeon will be influenced by the extent to which he is convinced that the improvements of modern surgery have lessened the risks of interfering with the contents of the abdomen, and of dividing the two layers of peritonæum; the intra-peritonæal method is especially indicated when the amount of distension of the intestines, or any evidence of matting of the structures of the abdominal wall (dating to any inflammation about the aneurism, or to the use of pressure), would probably interfere with stripping up the peritonæum.

A. *Through the Peritonæum.*—The bowels having been emptied as much as possible, the skin cleansed, the shoulders raised, and the knees slightly flexed, the surgeon makes an incision at least 4 inches long, in the middle line, with its centre opposite to the umbilicus, but curving a little to the left here, so as to avoid the round ligament of the liver and the urachus. The linea alba being found and divided, the fascia transversalis slit up, all hæmorrhage must be arrested before opening the peritonæum.† When this structure has been opened to the whole extent of the wound retractors are inserted, and the small intestine and mesentery drawn partly upwards and partly to the sides, carbolized sponges being packed around, if needful, to keep the above structures out of the way. The pulsation of the vessel is now felt for and the deeper layer of peritonæum carefully scratched through. Care should be taken to disturb as little as possible the aortic plexus‡ during this step and in passing the needle, which should be carried from right to left.

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* This interval varies in length from $\frac{1}{2}$ inch to 2 inches.

† In Mr. James's case (*Med. Chir. Trans.*, vol. xvi. p. 10) a large quantity of blood was found post-mortem in the abdominal cavity. This had come either from a vessel in the parietes, or from one wounded in the mesentery.

‡ Sir A. Cooper (*loc. supra cit.*) believed that his experiments on dogs proved that inclusion of this plexus, and not the interruption of the circulation, was the cause of the paralysis which followed the experiment. In Mr. James's case, when the ligature was tightened, the patient complained of "deadness in the lower

The ligature used should be one of the flat tape-like ones, of kangaroo tendon or ox aorta (p. 540). The passage of the needle may be attended with much difficulty,* not only from the depth of the vessel, and from the presence of intestines if distended and allowed to protrude into the wound, but also from the denseness of the cellular tissue surrounding the artery.

B. *Behind the Peritonæum.*—This method should be tried in any case where the surgeon is unable to take those precautions for which intra-peritonæal surgery calls. The chief objection is the great depth at which the artery is reached, but it is well worthy of notice that in Monteiro's case, which survived ten days, this method was made use of.

The operation is performed on much the same lines as that already given for ligature of the common iliac (p. 625). The incision should be as free as possible, from the top of the tenth rib, curving somewhat forwards to the anterior superior spine.† The muscles and transversalis fascia being cut through, the peritonæum is stripped up and turned inwards, several large retractors placed in the wound, and the rib dragged up and outwards. The common iliac being found this vessel is traced up into the aorta (Fig. 107).

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extremities." This was soon followed by agonizing pain in the same parts, only relieved by death about three hours after the operation.

[*] Thus, in Mr. James's case the aneurism-needle broke at its handle, the surgeon having "little anticipated occasion for so much force." In one case the sac gave way during the operation.

[†] If necessary, a horizontal one might be added, at right angles to the first, but the rectus and the deep epigastric should on no account be interfered with.

CHAPTER II.

OPERATIONS ON HERNIA.*—OPERATIONS FOR STRANGULATED HERNIA.—RADICAL CURE OF HERNIA.

OPERATIONS FOR STRANGULATED HERNIA.

Chief Indications for Operation and Points to bear in Mind.—While this is not the place for going into the above fully, a few practical remarks on those indications usually given may be helpful to some of my readers.

i. A lump in one of the openings more or less hard, tense and tender, partly or completely irreducible, and with impulse doubtful or absent.

a. The swelling may be small and deep-seated, as in a bubonocele near the internal ring, or a femoral in a fat patient.

b. Two herniæ may be present, both irreducible. The surgeon should operate on the one which is the more tense and has the least impulse, and the one which has most recently descended. If this fail to give relief, either the opposite swelling must be explored or abdominal section performed in the middle line. This step will probably allow of the opposite hernia being reduced from within, and also of any other possible seats of strangulation being explored—viz., the inner aspects of the deeper rings.

c. As to the impulse, it is worth while to observe carefully the point where this ceases. This, probably, is over the site of stricture, and should be about the centre of the incision.

d. Sir J. Paget (*Clin. Lect.*, p. 108) thus writes of the hardness of a hernia :—" In large herniæ the hardness may chiefly be felt at and near the neck and mouth of the sac, especially in inguinal herniæ, and you must take care not to be deceived by a sac which is soft and flaccid everywhere except at its mouth, for there may be strangulated intestine in the mouth of the sac though the rest contain only soft omentum or fluid not sufficient to distend it; nay, you must not let even a wholly soft condition of the hernia, or an open external ring, weigh down against the well-marked symptoms of strangulation, for the piece of intestine at the mouth of the sac may be too small to give a sensation of hardness, or the whole hernia may be omental."

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* The different forms of hernia, those which present on the thigh as well as the inguinal and umbilical varieties, will be considered here for the sake of convenience, and because they are all abdominal in origin.

ii. Constipation becoming absolute, even as to flatus. It is well known that small scybalous motions may be forced out by the straining of a patient with a strangulated hernia anxious to get his bowels to act. Further, and in intestinal obstruction generally, the bubbling away of an enema may simulate the passage of flatus. In those rare cases where, other evidence of strangulation being present, the bowels continue to act at intervals, it is probable that the constriction of the bowel is not complete, and leaves a channel along the mesenteric border. If such cases have been left long, owing to the absence of constipation and, perhaps, the slightness of the vomiting, the surgeon must examine the bowel very carefully before he return it. Constriction, though only partial, may have here caused, from its long duration, thinning or ulceration of the intestine at one spot, and great extravasation may take place as soon as the bowel is returned. If there is any reason for doubt in these cases the stricture should be thoroughly divided and the bowel left *in situ*.

iii. Vomiting.* Especially if (*a*) this is changing from the early rejection of stomach contents or bile to feculent fluid ; (*b*) even if it is repeated only at long intervals, and all other signs are absent or little marked ; (*c*) it must be remembered that vomiting may be stopped by drugs, strangulation persisting, or the intestines may be empty.

iv. Tympanitis and other evidence of peritonitis.

These will not, of course, debar the surgeon from operating, but they will lead him to warn the friends that relief will probably come too late.

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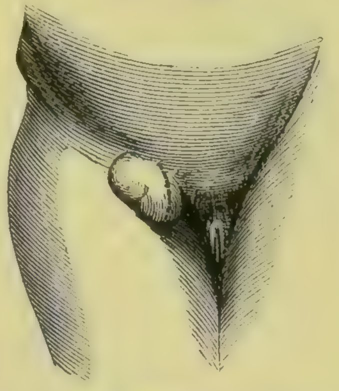
* Sir J. Paget (*loc. supra cit.*, p. 112) says : "If I were asked which of the signs of strangulation I would most rely on as commanding the operation, I should certainly say the vomiting." Later on (p. 114) he urges that the practitioner should not wait for any characteristic mode of vomiting, nor be misled by the absence of any particular fluid, nor even by the absence of all vomiting, nor under-estimating the importance of occasional vomiting as a signal for operation.

STRANGULATED FEMORAL HERNIA (Fig. 109).

Operation.*—The parts being shaved and cleansed with soap and carbolic-acid lotion (1 in 60) or perchloride of mercury lotion (1 in 1000), a little iodoform rubbed in around the genitals, the limbs being kept warm with blankets and a hot bottle or two, if the patient's vitality is low, and the knee flexed slightly over a pillow, an incision 1½ to 2 inches long is made vertically on the inner side of the swelling.† Some small branches of the superficial external pudic occasionally require torsion or ligature. The cribriform fascia and the fascia propria (femoral sheath and septum crurale) are next divided in the same vertical line with or without a director,‡ according to their thickness and the experience of the operator, all the incisions made going quite up to and above the top of the swelling, so as to lie over the seat of strangulation, usually Gimbernat's ligament.

Fig. 109.



In the operation without opening the sac,§ the site of stricture must next be found. The varieties here are best given in Sir James Paget's words: (*loc. supra cit.*, p. 132). "In some instances, as you trace up the neck of the sac, you find it tightly banded across by the layer of fibrous tissue called Hey's ligament—a layer traceable as a falciform edge of the fascia lata, where that fascia, bounding the upper part of the saphenous opening, is connected with the crural arch, and is thence continued to Gimbernat's ligament. Sometimes a fair division of this layer of fibres up to the edge of the crural arch is sufficient to render the hernia reducible. . . . . But in more cases this is not sufficient, and you may feel the stricture formed by bands of fibres which encircle the neck of the sac, and which must be divided, band by band and layer by layer, till none can be felt. These fibres are part of the deep crural arch. Very rarely, however, even the division of these is not sufficient, for the stricture is formed by thickening of the mouth of the sac itself. This condition, which is a common cause of stricture in inguinal hernia, is very rare in femoral; but it certainly does occur, and in any case well suited for the operation, without opening the sac, you may try to thin the mouth of the sac without opening it, and thus to make it extensible enough for the return of its contents. You may try this, but the chances of success are small. You are much more likely to cut into the sac at some thin place, and when you have done this you had better enlarge the opening and divide the stricture from within."*

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* While general anæsthesia will be preferred in most cases from the more certain loss of sensibility and the relaxation of the parts, a case related by Dr. Mason (*Brit. Med. Journ.*, vol. i. p. 834) shows how valuable cocaine may be as a local anæsthetic. A woman who had suffered from heart disease for many years required operation for a strangulated femoral hernia. Three four-minim injections of a 4 per cent. solution of cocaine were given, the first under the skin over the centre of the tumour, the second above and the third below the tumour, as deeply towards the femoral ring as was thought safe. It was only during actual division of the sac and the insertion of the sutures that any pain was complained of. The wound healed by first intention.

† This incision is usually made in the ordinary way. A somewhat quicker method is by incising or transfixing a fold pinched up at a right angle to the long axis of the swelling, and held by the fingers of the surgeon and an assistant. Before beginning the operation, the surgeon should always examine into the probable amount of fat, and thickness or thinness of the hernial coverings. In the case of a large hernia turning outwards and upwards, it may be well, at a later stage of the operation, if any additional exploration is required of doubtful contents, to convert the first incision into a ⊣.

‡ If a director be not forthcoming the operator will manage very well with cissors, keen-edged, but blunt-pointed.

§ Cases best suited for this plan are those where the strangulation has been hort; its symptoms not very severe—*e.g.*, the vomiting only bilious; where the ernia is small in size and without mixed contents; where the patient is in good ondition, and any previous taxis has been gentle and brief.

Operation by Opening the Sac.—In this and in the former case much difficulty is occasionally met with in deciding as to whether the sac is reached or no. The causes of difficulty here are mainly—(1) An altered condition of the soft parts from the pressure of a truss, or from long strangulation; (2) from meeting with fluid outside the sac; (3) from the extreme thinness of the patient, which leads to the sac being reached unexpectedly; (4) from the opposite condition, much fat being met with in several of the deeper layers, making it uncertain which is the extra-peritonæal layer, the fat in these cases being often soft, and readily breaking down under examination; (5) an apparently puzzling number of layers—this condition is usually due to "hair-splitting" over-carefulness on the part of the operator, at other times it is brought about by a much thickened fascia propria[*] separated into imperfect layers by its softened condition or inflammatory matting; (6) by the absence of a sac.[†]

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* In trying to divide points of stricture outside the sac, attention should be paid to the following:—(1) First reaching the sac itself, if possible, by a careful division of all the overlying structures in the vertical incision carried well upwards; (2) Carefully drawing down the sac, so as to expose any fibres constricting its neck; (3) Gently insinuating the point of the director under any bands met with.

Aids in Recognizing the Sac in Cases of Difficulty.—Several of those ordinarily given[‡]—*e.g.*, "its rounded and tense appearance, its filamentous character, and the arborescent appearance of vessels on its surface"—are, I think, quite fallacious. So, too, with regard to the escape of fluid from the sac, for this is often dry in femoral herniæ, and occasionally fluid is met with before the sac is reached. A smooth lining characteristic of its inner surface is more reliable, but the inner surface of the fascia propria is sometimes remarkably smooth. Two points remain which will help to solve the doubt—(*a*) To draw gently down the doubtful structure, whether sac or bowel, and to examine whether it is continuous above and below with the structures of the abdomen and thigh, like the other coverings of the hernia, or whether it has a distinct neck to be traced into the abdominal cavity; (*b*) To see if the point of a Key's director can be insinuated along this last doubtful layer into, and moved within, the peritonæal cavity or no. In a very few cases the surgeon, if still in doubt, incises carefully the suspected layer, and tries if he can pass in a probe and move it from side to side; if this can be done, he is still outside the bowel, not between the peritonæal and muscular coats of intestine.

The sac being carefully nicked with the scalpel-blade held horizontally at a spot where it can best be pinched up with dissecting-forceps, a matter of much difficulty at times owing to its tenseness, is slit up on a director, and its contents examined. If omentum first present itself, this is drawn to one side and unravelled, and intestine sought for. This usually takes the form of a small, very tense knuckle, of varying colour and condition. If it will facilitate the manipulations needful for reduction, the omentum may be first dealt with. (1) If this be voluminous and altered in structure, it should be tied,* bit by bit, with reliable chromic gut, and then cut away, the scissors being applied so close to the ligatures as to leave holding-room, but no excess to mortify or slough. After the return of the intestine, the omentum is also replaced within the abdomen. (2) If the omentum is small in amount and recently descended, it may be merely returned. (3) In a few rare cases when the omentum is intimately adherent to the sac, and the patient's condition does not admit of delay, the omentum may be left *in situ.* As, however, this course very much interferes with the satisfactory wearing of a truss, and as it is likely to lead to a fresh descent of bowel, it should never, if possible, be followed.†

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[*] The fascia propria, though sometimes of wafer thinness, may be much thickened and difficult of recognition. In Mr. Erichsen's words (*Surgery*, vol. ii. p. 821), "It not unfrequently happens that, after the superficial fascia has been divided, an oval, smooth, and firm body is exposed, which at first looks like the hernial sac or a lump of omentum. This is in reality the fascia propria, thickened by the long-continued pressure of the truss, and congested perhaps by the attempts at reduction; and in the midst of it the sac will at length be found, after the dissection has been carried through several layers of this tissue."

[†] A sac is said to be absent in some cases of hernia of the cæcum, and where the patient has been operated on before. This, however, was not the case in three herniæ containing the cæcum, and in two which had been operated on before, which came under my care.

[‡] Erichsen, *loc. supra cit.*

Reduction of the Intestine.—As soon as this is exposed, the surgeon examines with the little finger-nail, or a Key's director, the tightness of Gimbernat's ligament. In a few cases reduction may be at once effected by gentle pressure backwards on the bowel with the tip of the little finger. But in the large majority the above site of structure will need division, a point requiring much carefulness for fear of injuring the intestine or important surrounding structures. If the degree of tightness of the parts admit of it, there is no director equally safe and satisfactory as the index or little finger of the left hand passed up to the stricture, and the nail-tip insinuated beneath this, the hernia-knife being introduced along the pulp of the finger (Fig. 110). But there is rarely room for this, and a Key's director‡ must usually take the place of the finger. The tip of this instrument being insinuated into the peritonæal cavity just under Gimbernat's ligament, the hernia-knife§ is introduced obliquely or flat-wise upon it, its end slipped under and beyond the ligament, its edge turned towards the constricting fibres, and a few of these cut through in an upward and inward direction by a gentle movement of the wrist. In doing this it is well for the surgeon to draw down the edges of the cut sac close to its neck, and to ask an assistant to hold these, thus facilitating the passage of the director and the knife by preventing the sac falling into folds before them. Occasionally also a knuckle of intestine persistently coils over the edge of the director. This is best met by patience, by drawing it out of the way by the carbolized finger-tip of an assistant, or by pressing it down with the handle of a pair of dissecting-forceps.

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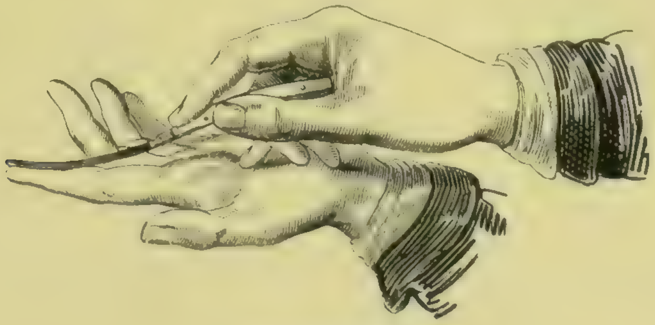
* For security's sake the ligatures should be made to interlock. If hæmorrhage occur from the omentum after it has been replaced, the surgeon must remember that returned omentum generally escapes far from the wound. It will thus be usually needful to extend the wound upwards along the linea semilunaris.

† The cause of the symptoms of strangulation which undoubtedly arise in herniæ containing omentum only, has been much discussed. Mr. Rushton Parker thinks that the symptoms are due either to the displaced omentum dragging on the colon, or to peritonitis: thus an inflamed omental hernia will throw out much serum and simulate strangulation. Mr. Holmes, who shows (*Lancet*, May 4, 1883) that the above explanations will not meet all cases, suggests that in some of the cases the function of the intestine is suspended by some reflex act arising in the nerves of the strangulated omentum.

‡ This director is broad, so as to prevent any intestine curling over and reaching the knife; blunt-pointed, so as not to damage the contents of the peritonæal cavity; finally, its groove does not run quite up to the end, so that the knife-point shall be stopped before it comes in contact with the important parts.

§ A curved one will be found most useful. The cutting-blade is usually too broad, and the tip too massive. On the other hand, a worn-down blade has been

FIG. 110.*



(Fergusson.)

The direction and the extent to which the stricture must be cut are matters of much importance. The upward and inward line is the only path of safety. Directly outwards lies the femoral vein; by cutting upwards, the spermatic cord, and, if upwards and outwards, the epigastric artery, would be endangered; behind are the peritonæum and pubes. The incision upwards and inwards must be of the nature of a nick; otherwise, owing to the imperfect healing of the fibrous structure, the ring will be left large and gaping, thus facilitating the re-descent of the hernia, and producing much difficulty in fitting on trusses, and causing certain discomfort and probable peril to the patient, especially if she belong to the poorer, hospital class.

Gimbernat's ligament having been carefully and sufficiently nicked, the bowel is replaced either by gentle squeezing between the finger and thumb, so as to empty it of its contents, or with the pressure of the little finger; the sac should now be kept stretched with forceps so that no folds interfere with the return

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known to break while dividing a tense Gimbernat's ligament. The intestine may thus be wounded, or the fragment of the knife escape into the peritonæal cavity.

* The cutting-blade of the knife shown here is needlessly long and unguarded.

of the bowel. If pressure on one part of the intestine fail, it must be tried at another point. After the reduction of the intestine the tip of the little finger should be introduced through the crural canal into the peritonæal cavity to see that the gut is absolutely safe ; a little iodoform is then dusted on to the stumps of omentum, and these too returned, if this has not been done.

If the patient's condition and age admit of it, and if the adhesions are not too firm, the sac should next be taken away by carefully separating it with the point of a director from its attachments. It should then be pulled well forwards, an aseptic finger introduced up to its neck, this part next ligatured with stout chromic gut as high up as possible, the finger then withdrawn, and the sac cut away ½ inch below the ligature. If the surgeon is at all doubtful about the safe ligature of any stump of omentum, he should keep this down and transfix it and the neck of the sac with a double chromic-gut ligature, the ends of which are afterwards cut short. Sufficient drainage is now provided by a small tube or a bundle of horsehair, and the superficial wound closed. The dressings must be applied with sufficient care to keep the wound secured from obviously close sources of contamination. It is well to place a separate pad of carbolized tow or salicylic wool over the anus and genitals, and to draw the water off before the patient leaves the table. The thigh should not be kept too much flexed, otherwise the escape of discharge from the drainage-tube will be interfered with.

The account of an ordinary operation having been given, it remains to consider certain **complications.** These are chiefly :

1. Adhesions of Bowel to the Sac or Omentum.—The treatment of this uncommon complication must vary with (α) the character and position of the adhesions, (β) the condition of the intestine, and (γ) the state of the patient. Owing to the difficulty of fitting on a truss if any of the hernia is left unreduced, every attempt should be made to free the contents by separating the adhesions with the point of a steel director, the finger-nail, or a blunt-pointed bistoury. When near the neck they must always be divided, sufficiently nicked, or stretched. No intestine and omentum if still adherent to each other should ever be returned. A few cases remain in which adhesions should be left alone. When gangrene is threatening, their presence, especially about the neck of the sac, is the chief safeguard against extravasation into the peritonæal cavity. In some cases of large hernia, if the patient is much collapsed, so long as any recently descended loop is returned any long-adherent intestine may be

left. And in other cases of collapse from delay of the operation, where there is much difficulty in returning a loop of intestine, especially if this is not in good condition, it may be left, after the stricture has been sufficiently divided.

It occasionally happens in these cases of deeply congested bowels, especially in inguinal hernia, that after an otherwise successful herniotomy the patient passes profuse and bloody stools. This condition may prove fatal. In one of two cases of this kind which have come under my notice the operator was, most unfairly, blamed for incising the bowel. Mr. Kough (*Lancet*, Oct. 11, 1884) records a case in which a patient died in collapse two hours after the reduction of a very large scrotal hernia. The pelvic cavity was full of bloodstained serum; ten feet of intestine were found dark purple in colour, but uninjured. On laying the gut open about 1½ pint of blood escaped.

2. Tightly Constricted or Gangrenous Intestine.—In spite of all that has been taught about the importance of early operations, cases do still occur in which the advisability of returning the bowel seems doubtful. In most cases of doubt, as long as the stricture is sufficiently divided and the intestine placed only just within the crural ring (the wound being left open and the sac not ligatured in these cases), the interior of the abdomen is the best place for the intestine. And this is true of congested intestine, however deeply loaded with blood only, as long as there is some shade of red present. But on these points nothing will surpass the advice of Sir J. Paget (*loc. supra cit.*, p. 138): "You are to judge chiefly from the colour and the tenacity. Use your eyes and your fingers; sometimes your nose; very seldom your ears, for what you may be told about time of strangulation, sensations, and the rest is as likely to mislead you as to guide aright. As to colour . . . . I am disposed to say that you may return intestine of any colour short of black, if its texture be good; if it feels tense, elastic, well filled out, and resilient, not collapsed or sticky; and the more the surface of the intestine shines and glistens, the more sure you may be of this rule. When a piece of intestine is thoroughly black, I believe you had better not return it, unless you can be sure that the blackness is wholly from extravasated blood. It may not yet be dead, but it is not likely to recover; and, even if it should not die after being returned, there will be the great risk of its remaining unfit to propel its contents, and helping to bring on death by what appears very frequent—distension and paralysis of the canal above it. But, indeed, utter blackness of strangulated intestine commonly

tells of gangrene already; and of this you may be sure if the black textures are lustreless, soft, flaccid or viscid, sticking to the fingers, or looking villous. Intestine in this state should never be returned. Colours about which there can be as little doubt, for signs of gangrene, are white, grey, and green, all dull, lustreless, in blotches or complete over the whole protruded intestine. . . . . Then as to the texture of the intestine: It should be, for safety of return, thin-walled, firm, tense, and elastic, preserving its cylindrical form, smooth, slippery, and glossy. The further the intestine deviates from these characters, the more it loses its gloss and looks villous, the more it feels sticky and is collapsed and out of the cylinder form, the softer and more yielding, the more pulpy, or like wet leather or soaked paper, the less it is fit for return. And when these characters are combined with such bad colours as I have described, the intestine had better be laid open, that its contents may escape externally and do no harm."

In other long-standing cases of femoral hernia the chief stress of the constriction is shown, not on a dying loop of intestine, but in ulceration, partial or nearly ring-like, at the neck of the sac, under the sharp edge of Gimbernat's ligament. Where this condition, owing to the duration of the case, is suspected, the intestine should be very gently drawn down, and, if ulceration is found, laid open. If the mischief is localized and the adjacent intestine fairly healthy and not fixed, it will be well to stitch it to adjacent parts to prevent it slipping up into the peritonæal cavity.

It has been much disputed whether, in these cases, when the intestine is unfit to be returned, it is safe or needful to divide the stricture in addition to laying open the intestine. On the one hand, M. Dupuytren, Sir A. Cooper, Mr. Key, and Mr. Erichsen have advocated this step being taken; on the other, Mr. Travers and Sir W. Lawrence were against it. The following words of a very brilliant writer* will probably convince most that this step is not only injurious, but unneeded:—"The only result of this is that the protecting barrier which divides the still aseptic peritonæal cavity from the putrid sac, is broken down, and putridity spreads upwards into the abdomen and kills the patient by rapid septicæmic poisoning. Why break down this valuable wall? If it is argued that, unless the stricture is divided, the contents of the bowel cannot escape, then the reply is that experience proves this to be utterly untrue. In a very short time both flatus and fæces find their way out. As every one knows, the nipping of the gut is not produced by a sudden narrowing of the hernial aperture, but by a swelling of the loop of gut. . . . . When the gut is slit up, its contents are set free, and its inflammatory juices escape, with the result that its swelling goes down and room enough is soon permitted for wind and fæces to pass, more particularly as the fæces are invariably quite liquid."

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* Mr. M. Banks, *Clinical Notes on Two Years' Surgical Work in the Liverpool Royal Infirmary*, p. 96.

3. The formation of artificial anus, intestinal anastomosis, and resection of the intestine are considered at pp. 777, 775, 788. It will suffice here to say that in cases of hernia, owing to the condition of the intestine, the state of the patient, and often the absence of needful preparations and a good light, no attempt, as a rule, should be made to resect the damaged parts now.

4. Wound of Intestine.—This may be due to (*a*) carelessly incising thin, soft parts ; (*b*) great difficulty in making out sac and intestine in a fat patient, with the parts matted, especially if the light is bad ; (*c*) to the intestine being allowed to curl over the edge of the director while the stricture is being divided, or to this being cut with careless freedom, or, lastly, to a loop lying out of sight just above the constriction, and to the hernia-knife coming in contact with this. Any bubbling of flatus or escape of fæces from the wound must lead to a careful search for the opening. When this is found, it may usually be tied up around a pair of dissecting-forceps with carbolized silk, the ligature not being tied too tightly, and the ends cut short. If the opening be larger, it should be closed by Lembert's suture (p. 788, Figs. 119, 120). Whichever method is used, the injured part should be replaced just within the peritonæal cavity, and in a severe case the sac should not be taken away nor the wound closed. The patient should be kept under the influence of opium, and liquids restricted.

5. Wound of Obturator Artery.—The position of this vessel when it rises by a common trunk with the deep epigastric instead of from the internal iliac, which occurs in every 3½ subjects (Gray), may bear a very important relation to the crural ring. In most cases when thus arising abnormally, the artery descends to the obturator foramen close to the external iliac vein, and therefore on the outer side of the crural ring and out of harm's way. In a small minority of cases,* the artery in its passage

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* Sir W. Lawrence considered this risk to occur about once in a hundred times, estimating the origin of the obturator with the epigastric to occur once in five, and the descent of the artery on the inner side to take place once in twenty times.

downwards curves along the margin of Gimbernat's ligament, and may now be easily wounded.

The treatment is mainly preventive—*i.e.*, by making the smallest nick possible that will be sufficient into any point of stricture, such as Gimbernat's ligament, a point the importance of which has already been alluded to (p. 644), and using a hernia-knife that is not over-sharp. If the artery has probably been wounded, the following points are of interest:—(1) The hæmorrhage may not at once follow the wound. It may not make its appearance till the bowel is all reduced, or even until a quarter of an hour after the wound has been stitched up. In one case, that of Dupuytren, no hæmorrhage occurred, and the division of the artery was discovered for the first time at the autopsy three weeks after the operation. (2) It may occur when the sac has not been opened. (3) As is shown by Dupuytren's case, it is by no means a fatal accident. (4) Very various means have served to arrest the hæmorrhage. (*a*) Pressure usually applied by a pad,* as in the cases of Sir W. Lawrence, Mr. Hey, and Mr. Barker.† (β) Ligature of the vessel, usually the proximal end. In five cases given by Mr. Barker, this was successful in four; it is only stated in one that the distal end was also secured. The ligature had been applied in some cases by continuing the wound upwards; in others by making an incision parallel with Poupart's ligament, as if for tying the external iliac. This step should always be taken when the patient's condition is satisfactory.‡ (γ) By acupressure. This method was thus made use of by Mr. Corley: The gush of arterial hæmorrhage which took place the moment the intestine was returned was controlled by passing a curved needle through the ring, and bringing it out immediately above Poupart's ligament, and passing a figure-of-eight suture over it. No recurrence of hæmorrhage took place, but the patient died thirty hours later. At the autopsy about 4 oz. of clot were found in the subserous tissue. The obturator springing from the epigastric, and being about the size of a No. 3 bougie, took the dangerous course over the neck of the sac. The cardiac end was occluded by clot.

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* Or better, by pledgets of aseptic gauze or sponges dusted with iodoform, and secured by silk.

† *Clin. Soc. Trans.*, vol. xi. p. 180. This paper will well repay perusal. Most of the above information is taken from it.

‡ Mr. Hulke (*Lancet*, 1885, vol. i. p. 746) by freely opening up the wound and using large retractors found a comparatively large atheromatous artery spouting freely. From its position this was a large communicating artery between the deep epigastric and obturator, lying just behind Gimbernat's ligament. Both ends were secured with very great difficulty. The patient did well.

The distal end had retracted 1½ inch from the cardiac, and was open. Though the needle had controlled the hæmorrhage, it had not included the artery. In two of Sir W. Lawrence's cases the fainting of the patient appears to have decided the cessation of hæmorrhage. Both of these recovered. In the event of pressure failing, it might be worth while, before taking other steps, to try the application of a pair of Spencer Wells' forceps. These would be left *in situ* for three or four days, and would favour drainage.

(6) Herniæ with Unusual Contents.—These may be (α) Fat herniæ. Both in the inguinal and femoral regions, but especially in the latter, the extra-peritonæal tissue near the rings may become increasingly fatty. Gradually projecting towards the surface it drags down the peritonæum to which it is loosely connected. I have operated on one such case in a girl at nineteen, in whom the fitting of a truss was unsatisfactory. Here I expected to find an omental hernia. Into the pouch so formed intestine or omentum may present. In other cases if the extra-peritonæal fat thus protruded become absorbed, the hollow thus left may produce a space for the peritonæum to project into. (β) Hernia of the ovary. This is much more commonly met with in inguinal herniæ. The chief points in the diagnosis of these difficult cases are the characteristic oval shape and size of the swelling, the peculiar sickening pain when the swelling is pressed upon; the swelling is larger, and the tenderness greater during menstruation, the swelling may sometimes be made to move when the uterus is displaced laterally with a vulsellum, and the ovary of that side is not to be made out per vaginam. Where other treatment has failed, where the swelling is irreducible and prevents the fitting of a truss, where the symptoms are sufficiently urgent to cripple a young life, the displaced ovary should be removed. The operation should be rigidly aseptic. Adhesions are not uncommon. (γ) Hernia of vermiform appendix. I met with a case of this early in 1890, in a lady aged forty-three, a patient of Dr. Fraser's of Romford. The femoral hernia was here irreducible, dull, gave the feel of omentum, and curved upwards and outwards in the usual way. As no truss was satisfactory, and as the patient, the wife of a missionary, was to be much abroad, a radical cure was advised. The sac contained much fluid, but no omentum. In the outer part of the hernia lay a thick fleshy body, tubular and expanded at its end. Under Gimbernat's ligament it was constricted and distinctly abraded. After notching the above ligament this body, which proved to be the appendix, was easily returned. The sac was removed. The case did excellently.

Here my chief reasons for not removing the appendix were that the necessary suturing is tedious and not always secure. (δ) Hernia with more than one sac. This may be due to the presence of membrane, inflammatory in origin, which has divided the original sac.

Causes of Herniæ not doing well after the Operation.—(1) Peritonitis, usually from the operation being performed too late. (2) Enteritis. This may be told by the tympanitis, tenderness and vomiting being much less marked, and often, the presence of diarrhœa. (3) Septic trouble, erysipelas. The six following are the causes of intestinal obstruction after hernia operations. (4) The descent and restrangulation of the bowel. (5) So much damage to the intestine that it lies paralysed in the peritonæal cavity.* (6) Cicatricial stricture of the intestine. (7) Fixing of the bowel after its reduction by adhesions to the abdominal wall.† (8) Formation of a band out of the above adhesions. (9) Fixing of the two ends of a loop of intestine by adhesions. (10) Formation of an omental band in the neighbourhood of one of the hernial orifices, a band so formed causing obstruction later (*Brit. Med. Journ.*, 1879, vol. ii. p. 491). (11) A very rare condition. The sac may be multilocular; when the intestine is reduced it may be returned into one of these cavities instead of within the abdomen. Mr. Bellamy has published such a case (*Lancet*, 1886, vol. ii. p. 433). A good illustration of this is given by Mr. Holmes's *Surgery*, p. 698, fig. 322; the patient here died eight days after an operation for strangulated hernia.

STRANGULATED INGUINAL HERNIA (Figs. 111, 112).

Operation.—In considering this it will not be needful to go again into detail, as in the case of Strangulated Femoral Hernia; the chief points of difference and those of importance will be considered carefully.

The parts being shaved and cleansed (p. 641), and the thigh a little flexed, an incision 2½ inches long at first is made in the long axis of the tumour, with its centre (in an ordinary scrotal case‡) over the external abdominal ring. This incision may be made either by pinching up a fold and cutting from within outwards, or by cutting, in the usual way, from without inwards. The pressure-forceps may be left on the external pudics (both superior and inferior), these vessels being finally closed by the sutures which unite the wound. As the layers are divided, the knife being kept strictly in the same line throughout, some arching fibres of the inter-columnar fascia may be seen above, but the first layer usually recognized is the cremasteric fascia, often much thickened. After this the transversalis fascia, often much thickened and vascular-looking, is slit up, and any extra-peritonæal fat overlying the greyish-blue sac looked for. The surgeon now sees if he can find any constricting fibres outside the sac, and slits them up on a director. The more voluminous the hernia the more important it is to avoid exposure and manipulation of its contents by opening the sac.* But in the majority of inguinal herniæ the surgeon must be prepared for opening the sac. As soon as this is done, with the precautions already given (p. 643), the contents are examined, omentum got rid of if this step will give more room, and the site of stricture found with the finger-

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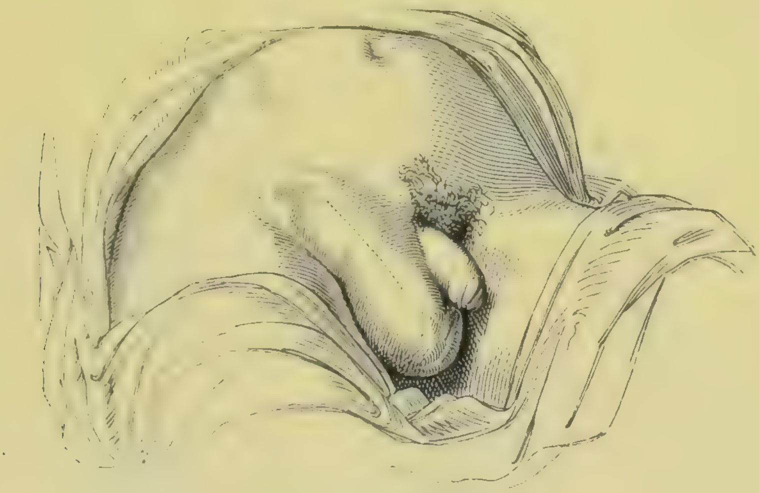
* I have recorded (*Brit. Med. Journ.*, 1879, vol. ii. p. 491) an instance of this in which ten days after an operation for intestinal obstruction by bands, death took place from the intestine never having recovered itself.

† This and the next three are given by Mr. Treves, *Lancet*, 1884, vol. i. p. 1022.

‡ In a strangulated bubonocele the centre of the incision should lie over the internal abdominal ring, and, in the deeper part of the incision, the deep epigastric must be felt for and avoided.

FIG. 111.



(Fergusson.)

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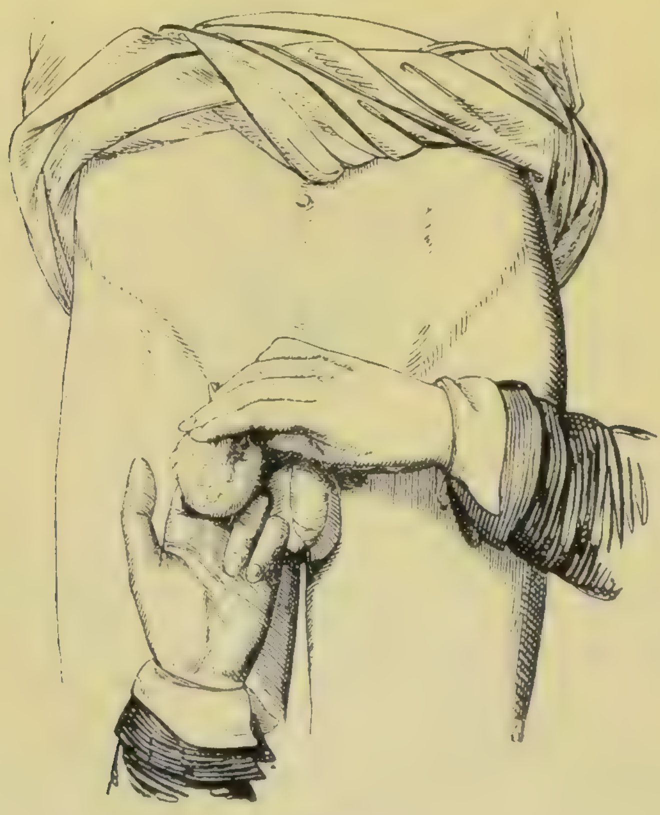
* The site of the stricture in inguinal hernia varies. In both varieties, in old cases of long duration, it is usually situated in the neck of the sac itself, owing to contraction and thickening of this and the extra-peritonæal tissue. In other cases of oblique hernia the stricture is found in the infundibuliform fascia at the internal ring, just below the edge of the internal oblique in the canal, or at the external ring. In a direct hernia the constricting point, if not in the sac, is probably caused by the fibres of the conjoined tendon. In many cases the parts are so approximated and altered that in the short time given by an operation it is not so easy to tell exactly in what tissues lies the strangulation, as to relieve it. Finally, in many cases of young subjects and acute strangulation, muscular spasm—*e.g.*, of the internal oblique—must be borne in mind.

nail or tip of the director. It is next divided with the hernia-knife manipulated under it in a direction directly upwards, so as to lie parallel with the deep epigastric, whichever side of the hernia this vessel occupies.* During this stage, the steps given at p. 649 must be taken to avoid any injury to the intestine. The constricting point being divided and dilated, the next step is **reduction of the intestine.** This, in bulky inguinal herniæ, is often a matter of difficulty and time. The **chief causes of difficulty here** are—(1) A large amount of intestine, one or two coils of small and some large intestine being not very uncommon. (2) The distension of these with flatus, &c. (3) Insufficient division of the stricture; or there may be a point of stricture higher up than the one divided, and overlooked. (4) During attempts at reduction one bit of intestine may get jammed across the ring instead of slipping up along it, and against this the rest of the contents are fruitlessly pressed. (5) Folds of the sac may in much the same way block the opening.

Fig. 112.



(Skey.)

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* Of course, if the surgeon is certain that he is dealing with an oblique hernia, he may cut outwards, and, in the case of a direct hernia, inwards, so as to avoid the deep epigastric. In all cases the cut should be of the nature of a nick dividing only those fibres which actually constrict, any additional dilatation being usually now effected by the tip of the director or finger.

Aids in Difficult Cases.—First, that part which lies nearest the ring should be taken—*e.g.*, mesentery before intestine. After each part is got up, pressure should be made on it for a few seconds before another is taken in hand. If the surgeon find, after a while, that he is making no progress with one end of a coil, he should take in hand the other end, or another coil altogether if more than one is present. Much of the difficulty met with in the reduction of the intestine is due to the surgeon not first unravelling the coil or coils, not duly tracing up the intestine to the ring, so as to make out the relations of the two, and, above all, to his not making up his mind which end of the coil it is exactly which he intends to begin reducing. During the manipulations the thigh should be flexed and rotated a little inwards, and the cut edges of the sac drawn tense with forceps, so as to prevent any folding or pushing up of this before the intestine. If the intestines are much distended, attempts should be made to return some of their contents first into the abdominal cavity. After by gentle squeezing with the finger and thumb, and careful pressure upwards on each successive bit of intestine, it all appears to be returned, the little finger (aseptic) must be passed into the abdominal cavity to make certain that no knuckle remains in the canal or internal ring.

In the case of large scrotal herniæ, where opening the sac in the ordinary way involves much exposure of peritonæal surfaces, I believe the following method to be preferable: A small opening just large enough to admit the left index finger (previously rendered aseptic), is made in the sac just below the seat of constriction. This is then divided on the finger as a director, *from without inwards.* The sac should not be again *opened* here, but after all the constricting bands have been felt and perhaps heard to give way, the finger easily dilates the communication with the peritonæal cavity and then reduces the contents of the sac. I have used this method twice, and with excellent results. It reduces the necessary disturbance of peritonæal surfaces to a minimum. Where from long strangulation it is advisable to inspect the contents of the sac, or where these are adherent, the sac must be more freely opened.

Cases will occasionally be met with where, owing to the low condition of the patient, the large amount of intestine down, its great distension, its altered condition, still red and only congested, but softened, with the peritonæal coat shaggy rather than lustrous, and tending to tear easily, it is clear that reduction will not be effected by manipulation only. The question now arises which of these courses is the wisest—to make a small incision, empty the intestine,* and then to close with sutures after Lembert's method (Figs. 119, 120), or to tie up the opening, picked up on a pair of forceps, with carbolized silk,† or to leave the intestine in the sac after a free division of the stricture. The first of these can only be followed when the intestine is healthy, and thus by peristaltic action the opening in the muscular coat will be carried past that in the serous, the two not corresponding, and when aseptic precautions have been carefully followed. Even when the intestine is opened, it is difficult to empty more than one loop of intestine. If there is any doubt about these, or if the intestine is much congested and softened, the surgeon had best be content with a free division of the stricture upwards and leaving the intestine in the sac.‡ This method is, on the whole, the safer, but prevents, of course, any attempt at relieving the patient, at one operation, by a radical cure.

During any prolonged manipulation of the intestines these should be kept covered as much as possible by green protective wrung out of warm boracic acid, or carbolic (1 in 80), or lint, the fluffy side being turned away from the bowel. It is wise also that the patient should be well under the anæsthetic now, and breathing quietly. If vomiting occur, the surgeon must wait, keeping up pressure on what he has reduced. When the intestine is all reduced, any ligatured stumps of omentum are returned, and, if the condition of the patient admits of it, the sac is detached, ligatured, removed, and a few sutures inserted to close the dilated canal and external abdominal ring, the precautions as to the cord and other points given at p. 669 being carefully followed.

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* While the intestine is emptying, care must be taken to lead the contents well away from the wound.

† The ends of this will be cut short, and the precautions given at p. 649 in case of wound of the intestine in herniotomy followed.

‡ This will all gradually and slowly return into the peritonæal cavity. On this point the following case by South (*Chelius's Surgery*, vol. ii. p. 40) is of interest:—"I know by experience that if strangulation be relieved, it is of little consequence how much intestine be down. In reference to this point, I recollect the largest scrotal rupture on which I have operated, and in which, before the division of the stricture, there was at least half a yard of bowel down, filled with air; and, after the stricture had been cut through, at least as much more thrust through, so that I almost despaired of getting any back; yet, after a time, I returned the whole. To my vexation, however, next morning I found that my patient had got out of bed to relieve himself on the chamber-pot, and, as might be expected, the bowel had descended, and in such quantity that the scrotum was at least as big as a quart pot, and the vermicular motion of the intestine was distinctly seen through the stretched skin. Nothing further was done than to keep the tumour raised to the level of the abdominal ring, and by degrees it returned, and the patient never had an untoward symptom."

In this, as in other operations, the wound should be carefully sponged with mercury perchloride solution (1 in 2000), and left exposed as little as possible, especially the parts near the opening into the peritonæum.

In providing drainage after an operation on a large inguinal hernia, where the parts have been much handled either before or during the operation, it is well worth while to bring the lower end of the drainage-tube out at the lower part of the scrotum, by means of a counter-puncture there, thus ensuring efficient escape of the discharges, and syringing out of the wound if needful.

After thus considering the chief points in the operation, it remains to draw attention to **some special points connected with inguinal hernia.**

I. *Varieties.**—In addition to the oblique and direct varieties, both of which are acquired, there are some others of much practical importance—*e.g.*,

(*a*) The congenital. The tubular process of peritonæum is open from abdomen to fundus scroti, and the contents lie in contact with the testis.

(*b*) Hernia into the funicular process of peritonæum. Here the tubular process of peritonæum is divided into a shut vaginal sac below and an open funicular process above. Into the latter the contents descend, but are not in absolute contact with the testis.

(*c*) Hour-glass contraction of the sac. Here the tubular process is open as in (*a*), but an attempt at closure has brought about a constriction which may be at the external abdominal ring or lower down in the scrotum. If the contents pass through this constriction, and get low enough, they will be in actual contact with the testis.

(*d*) Encysted hernia of the tunica vaginalis. Here the funicular process is closed at its abdominal extremity—*i.e.*, at either ring or in the canal—and open below to the testicle. Here the hernial protrusion as it comes down either ruptures this septum (when of sudden descent), or gradually extends and inverts it, or comes down behind it. These are rare, but may be puzzling when they occur, as the operator has more than one layer of peritonæum to incise before reaching the contents, two or three being met with according as the descending hernia has brought a layer of parietal peritonæum with it or no, and according as the septum has been ruptured or stretched.

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* These varieties are clearly described by Mr. Birkett (*Syst. of Surg.*, vol. ii. pp. 798, 799, figs. 164, 165). See also the diagrams in Mr. Bryant's *Surgery* (second edition), vol. i. p. 601.

That the above varieties have an importance beyond that of anatomical puzzles is shown by the fact that in (*b*), (*c*), and (*d*) strangulation may be very acute and urgent. Again, though the defect is a congenital one, the hernia does not, in many cases, make its appearance till the patient has, in early adult life, been subjected to some sudden strain. Finally, in these cases any prolongation of the taxis will be not only futile, but actually dangerous, owing to the tightness of the strangulation and the facility with which, owing to the delicacy of its adhesions, the sac may be separated or burst.

II. *Reduction en masse, and Allied Conditions.*—These have been chiefly met with in inguinal herniæ owing to the loose connections of the sac and, sometimes, to the force used in attempts at reducing large specimens. Strangulation may persist after (*a*) displacement, or (*b*) rupture of the sac. In the former, the sac, still strangling its contents at its neck, is displaced bodily between the peritonæum, usually, and extra-peritonæal fascia. In the latter, the sac is rent, usually close to its neck and at its posterior aspect, and some of its contents are thrust through into the extra-peritonæal connective tissue. The chief evidence of these accidents is—Though the swelling has disappeared, perhaps completely, this has taken place without the characteristic jerk or gurgle. On close examination, though the bulk of the hernia is gone, some swelling, often tender, is usually to be made out, deep down, in the neighbourhood of the internal ring. Above all, the symptoms persist, perhaps in an intensified form.

The treatment is immediate exploration of the inguinal canal and the internal ring. If the cord is exposed, the whole sac has probably been detached. If any of the sac is left above, a rent in it should be sought for. Supposing the index finger, passed through the internal ring, fail to find any swelling, aided by pressure from above, a vertical incision must be added to the upper end of the oblique one, and the neighbourhood of the internal ring explored.*

III. *Retained Testis simulating Hernia.*—Such a testis, when inflamed, may closely simulate strangulated hernia. A testis, perhaps, has never descended; a truss has been worn and laid aside. The patient presents himself with a tender swelling in one groin, with indistinct impulse. The abdomen is tense and full, constipation is present, and perhaps vomiting of bilious stuff. Such a swelling should be explored and the testis removed, as it is certain, later on, to cause serious trouble, even if the present urgent symptoms subside with palliative treatment. In other cases a retained testis may draw down an adherent loop of intestine which may become actually strangled.*

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* As this will probably involve abdominal section, the steps given further on should be referred to.

STRANGULATED UMBILICAL HERNIA.

Two distinct forms of strangulated hernia will be met with here. One, more rare, is of small size, with a single knuckle of intestine acutely strangled in the navel-cicatrix. The other, the more common, is often huge, its contents mixed, intestine both large and small, and omentum. Such herniæ soon become, in part at least, irreducible ; when in this condition, any unwise meal may readily bring about obstruction, a condition requiring much care to tell from strangulation.† In other cases a large irreducible hernia may easily become strangulated from the descent of some additional loop of bowel. The adequate fitting of a truss is often a matter of much difficulty here, owing to the large size of the abdomen, the presence of omentum, and, frequently, of an habitual cough.

Practical Points before Operation.—(*a*) The sac usually communicates directly with the general peritonæal cavity by a large opening. (β) The contents are not only mixed, but of long standing, and often adherent. (γ) The patients are often advanced in life, stout, flabby, and not unfrequently the subjects of chronic bronchitis. (δ) The coverings are ill-nourished, and slough easily.

Operation.—The parts having been cleansed‡ by a thorough scrubbing with soap, and soaking with 1 in 1000 solution of mercury perchloride, and an anæsthetic administered, an incision 2 to 3 inches long is made over the lower* part of the swelling in the middle line, the hernia being somewhat pushed upwards to facilitate this.† The thinness of the coverings must be remembered. Search should be made for any constricting bands of fibres outside the sac. If it be needful, the sac must be opened, with the knife held horizontally, and slit up, care being taken now and throughout the operation, in cases of large herniæ, that protrusion of intestine be prevented by the means given a little later. The contents having been examined, any intestine is gently displaced upwards, while the surgeon turns the curved surface of a Key's director over the lower edge of the opening, and, guiding the hernia knife on this, divides the constricting edge downwards. If sufficient space is not given, the downward nick may be repeated, or the director turned against the lateral or upper aspects of the ring, and fibres here also divided.

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* For fuller information on these matters I would refer my readers to my article on "The Diseases of the Male Organs" (*Syst. of Surg.*, vol. iii. p. 471).

† Amongst the most important points will be the vomiting, whether early in onset, constant, and showing signs of becoming feculent, and the constipation, whether absolute, even to the passage of flatus. In doubtful cases the rule should be to operate. "The risk of operating on a hernia which is inflamed and not easily reducible is very small in comparison with the risk of leaving one which is inflamed and strangulated; and even if you can find reasons for waiting it must be with the most constant oversight, for an inflamed and irreducible hernia may at any time become strangulated, and will certainly do so if not relieved by rest and other appropriate treatment" (Sir J. Paget, *loc. supra cit.*, p. 106).

‡ This is especially needful here from the numerous wrinkles of the skin and the frequent lack of cleanliness.

Adhesions of the contents of the sac are not unfrequently met with. If they are very close and dense, and if the condition of the patient is unsatisfactory, the surgeon should be content with a free division at one or two places of the constricting ring, and with reducing any portion of intestine that has clearly only recently come down, and leave the rest undisturbed.

A complication of large umbilical herniæ is thus well described by Mr. Wood (*loc. supra cit.*, p. 1168):

"In corpulent persons, in whom the operation has been delayed until peritonitis has begun, the operator has frequently to contend with a gush of bowels out of the abdomen. This should be restrained by receiving them in warm towels wet with carbolic lotion, and applying pressure by the hands of assistants. If it can be managed, all the operative proceedings within the sac should be done before such a rush occurs; but if a cough, or vomiting, or anæsthetic difficulty occurs at this juncture, this is sometimes impossible, and the surgeon is compelled to do the best he can. In such cases the operation becomes a formidable one indeed, and is comparable only to laparotomy under conditions of distension of the intestines. The bowels and omentum should always, if possible, be kept in the warm wet towels, and not indiscriminately handled by the assistants, whose arms should be bared and well purified with carbolized lotion. The intestines should always be returned before the omentum, which should, if possible, be spread out* over them before the stitches are applied."

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* The lower part is here recommended because, in Mr. Wood's words (*Intern. Encycl. of Surg.*, vol. v. p. 1165), "the point of strangulation in an adult umbilical hernia is most frequently at the lower part of the neck of the sac, where the action of gravity, the dragging weight of the contents, and the superincumbent fat, together with the pressure and weight of the dress or an abdominal belt, combine to press downwards upon the sharp edge of the abdominal opening. It is here that adhesions and ulceration of the bowel are most frequently found, and here the surgeon must search for the constriction in cases of strangulation." An incision here also gives better drainage.

† If the surgeon intends to attempt a radical cure, and if the skin is diseased, much thickened with old abrasions, he should remove this area by two elliptical incisions.

All the intestine and the remains of the omentum, carefully ligatured, being returned if possible, the surgeon now, if the patient's condition admits of it, removes the redundant sac and skin. The opening into the peritonæal cavity being closed with a small aseptic sponge secured to silk, or a flat sponge being inserted, the sac is separated from its connections and cut away close around the ring ; any bleeding-points can now be arrested by numerous strong chromic-gut sutures passed through the edges of the ring so as to close it save at the lower part, where a small-sized drainage-tube is left with its orifice flush with that into the peritonæal cavity.† Before the sutures are tied, any sponge which has been introduced into the abdomen so as to keep the operation as extra-peritonæal as possible, should be removed. The redundant skin is then cut away and the edges of the wound brought together with stout silk or silver sutures. The drainage-tube may be removed on the fifth or seventh day.

It will be seen from the above account that three methods may be pursued in the reduction of a strangulated umbilical hernia: (1) The division of the stricture outside the sac (p. 641). This should always be tried, but is rarely successful here. (2) If the sac has to be opened, the opening is made as small as possible, and the ring freely divided at one or two points, but the contents disturbed as little as possible, any recently descended intestine being returned, but thickened omentum, adherent intestine, especially large, being left undisturbed. (3) Free opening of the sac, examination and separation of its contents, return of all intestine and of omentum after ligature and resection.

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* Mr. Wood prefers leaving the edge of the omentum so arranged as to become adherent to the lower margin of the hernial opening, so as to prevent, if possible, any future protrusion, to tying it and cutting it short.

† Mr. Barker (*Brit. Med. Journ.*, 1885, vol. ii. p. 1101) advises the use of a double row of sutures—the first as given above to unite the edges of the ring ; the second, to give extra strength to the scar, are passed through the anterior layer of the sheath of the rectus on each side, at about $\frac{1}{3}$ inch from the edge of the ring. On these being brought together, a considerable fold of fibrous tissue is inverted and brought into contact in the middle line, over the first row which closed the ring.

While the third of these courses has the great advantage of leaving the patient permanently in a more satisfactory condition, as it admits of something like a radical cure,* the surgeon can only rightly decide between this and the second course by a careful consideration of each case. The following points may aid in judiciously selecting either operation:—(1) The size, long standing, previous attacks of incarceration and obstruction of the hernia, all these tending to bring about adhesions and alterations in the parts. (2) The condition of the patient—viz., the degree of flabby fatness, chronic bronchitis, probable renal and hepatic disease, amount of depression by vomiting and pain. (3) The facilities for carrying out during the operation, and, later, strict aseptic precautions. (4) The presence of the skilled help so essential in these cases. (5) The way in which the anæsthetic is taken. (6) The amount of experience of the operator. Thus a hospital surgeon, frequently operating and with all instruments and assistance at hand, may readily incline to one course, while the other may as wisely be followed by a surgeon who has to operate under very different circumstances.†

STRANGULATED OBTURATOR HERNIA.

This form of hernia has occurred too frequently to be entirely passed over. It may be so readily and fatally overlooked that a few words on its *diagnosis* will not be out of place.

(1) Position of the swelling. This appears in the thigh below the horizontal ramus of the pubes, behind and just inside the femoral vessels, behind the pectineus, and outside the adductor longus. (2) On careful comparison of the outline of Scarpa's triangles, a slight fulness is found in one as compared with the hollow in the other. (3) Pain along the course of the obturator

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* It will be remembered that it is not as essential to try and ensure a radical cure in the usual subjects of umbilical hernia as in children and young male adults, with the prospect of a long and active life before them.

† Mr. Clement Lucas (*Clin. Soc. Trans.*, vol. xix. p. 5) advocated more radical measures, such as excision of the sac and redundant skin, with suture of the ring, in all cases of umbilical hernia. Two successful cases are recorded, both excellent instances of this treatment, and one of especial interest, as the patient had been previously thrice tapped for ascites, and the operation allowed three pints and a half of fluid to escape.

nerve, down the inner side of the thigh, knee, and leg. (4) Persistence of symptoms of strangulation, the other rings being empty or occupied by reducible hernia. (5) A vaginal or rectal examination.

Operation.—Two different ones present themselves: (i.) by cutting down on the sac as in other herniæ; (ii.) by abdominal section, and withdrawing the loop from within.

(i.) It is noteworthy that this hernia was thus first successfully operated on by a general practitioner, Mr. Obré.

The parts being duly cleansed and slightly relaxed, an incision is made parallel to and just inside the femoral vein.* The saphenous opening being probably exposed in part, the fascia over the pectineus is next divided, the fibres of this muscle having been torn through with a director,† the obturator muscle covered by its fascia and some fatty cellular tissue is next defined, and the hernial sac probably now comes into view, either between the muscle and the pubes, or between the fibres of the muscle. If the case is a recent one, attempts are now made to reduce the hernia without opening the sac. If the sac has to be opened, and any constriction divided, the knife should be turned either upwards or downwards, the latter being the easier if any constricting fibres intervene between the sac and the bone. As the obturator vessels lie usually on one side or the other, a lateral incision must be avoided.

Care must be taken to keep the femoral vessels drawn outward with a retractor, while any branches of the obturator or anterior crural nerve are drawn aside with a blunt hook, the same precaution being taken with the saphena vein.

When by the passage of the little finger into the abdomen it is certain that the intestine is reduced, if the condition of the patient admits of it, the sac is separated and ligatured close to the thyroid foramen and removed. Drainage must be provided with aseptic horsehair or a fine tube.

(ii.) The operation of abdominal section will perhaps be more frequently performed in the future. An obturator hernia was thus reduced by Mr. Hilton in a case which simulated intestinal obstruction. Some empty intestine being found and traced downwards, led to the detection of an obturator hernia, which was reduced by gentle traction aided by firm pressure made deeply in the thigh. The patient, who was not operated on till the eleventh day, died of rapid peritonitis.

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* Mr. Birkett (*loc. supra cit.*, p. 830) says the incision "may commence a little above Poupart's ligament, at a point midway between the spine of the pubes and the spot where the femoral artery passes over the ramus of that bone."

† If it will give more room, they may be divided transversely for 1½ to 2 inches, as in Mr. Obré's case.

Mr. Erichsen briefly mentions a case operated on by this means in 1884 by Mr. Godlee. The hernia was reduced without difficulty, but the patient, who was much collapsed at the time, died in about twenty-four hours.

The duration of the hernia and the condition of the patient must be considered in selecting one of the above operations. Where the patient is much exhausted, the shock of an abdominal incision should, I think, be avoided; and where a much-damaged intestine is present, it may give way when withdrawn, causing extravasation into the peritonæal cavity.

RADICAL CURE OF HERNIA.

Before describing the different methods, the following points claim attention, and while the improvements of modern surgery have established radical cure on a sound scientific basis, many questions remain quite undecided.

Permanency of cure. Advisability or need of wearing a truss. Term, "radical cure." Age.

On these points I would refer my readers to the writings of Mr. M. Banks,* as one of the earliest and foremost workers at this subject, and to the difficulty of some of his cases and the honest frankness with which he has given his results. His experience is gained from 106 cases, 68 of which were without strangulation, while in 38 strangulation was present. Of 66 of these cases in which he was able to follow up the result, 44 were completely successful, 7 partially so—*i.e.*, though there was a distinct tendency to return, the hernia could now be kept up by a truss, a thing impossible before.

Mr. Banks considers the term "radical cure" misleading. "It is popularly understood that a patient upon whom a radical cure has been performed need never again wear a truss nor ever again be in danger of his hernia coming down. This is, unfortunately, far from being the case. The instances in which a light truss can be dispensed with are the minority."

Other surgeons hold a different opinion. Thus, Dr. Macewen (*Brit. Med. Journ.*, Dec. 10, 1887), in a brilliant series of cases

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* Pamphlet, *loc. infra cit.*; *Med. Times and Gaz.*, 1884; *Brit. Med. Journ.*, December 10, 1887.

—81 in all, in 29 of which strangulation had been present—without any death, merely states that 4* subsequently wore a pad or bandage.

Mr. Barker † has had no death in a series of 41 cases. Seven of these were lost sight of; of the others recurrence had taken place in five. He does not recommend the use of trusses except in cases of umbilical herniæ.

Many other surgeons might be quoted as deprecating trusses altogether, or any save of the lightest.

With regard to children, from an experience of 17 cases, I think that if the recumbent position be insisted on for three months after the operation, so as to give the newly restored parts time to consolidate, a truss will not subsequently be required, so great is the tendency to repair in early life.‡

While it will be at once granted that any continuous pressure in the form of a pad with a strong spring will tend to weaken the inflammatory thickening resulting from the operation, most surgeons will prefer that their patients should, for some years at least, wear a light but well-fitting support, especially in cases where the hernia and rings have alike been large, where the work involves sudden strains, or where the patient is flabby or develops an habitual cough.

Indications.—The following are given only as types of appropriate cases. Many others will suggest themselves:—

i. Children of poor and ignorant parents, with large herniæ, where proper attention to the use of a truss cannot be secured.

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* In one of these the parts were firm; in the others support was worn as a precautionary measure, one patient being of lax habit, another having had a direct hernia with a very wide opening, while the occupation of the third demanded much exertion.

† *Brit. Med. Journ.*, December 3, 1887. Mr. Barker allows, however, that in one recurrence the patient had been at very hard work, ever since the operation, without a truss.

‡ Some of the conclusions of Prof. Socin, of Bâle (*Deut. Zeit. f. Chir.*, 1886, Bd. xxiv. Hft. 3 and 4; *Annals of Surgery*, March, 1887), will well bear quoting here:—(1) Permanent cure is possible; it is the rule in recent herniæ; in other ones it is the exception. (2) Permanent cure is more prominent in those who have not completed their growth, other things being equal. (3) Prognosis as to permanency of cure is unfavourably influenced by the existence of another hernia in the patient, as well as by a family history of hernia. (4) Habitual bodily labour appears to favour a permanent cure; coughing, on the contrary, tends to cause relapse. (5) Probability of recurrence constantly decreases from the time of operation, being very slight indeed after the lapse of two years. (6) The most favourable method of performing the radical cure is to ligate the sac doubly or repeatedly at as high a point as possible, and to excise it. Suture of the constricting ring is not advisable.

It will probably be justifiable to go further than this, and to operate for radical cure in most cases of herniæ in the children of the poor in which the hernia is still distinct at four years of age.* By this time the parts are larger and more easily kept sweet. The sac is more easily dealt with now than later.

ii. Herniæ, especially inguinal, in men under thirty-five, interfering with the activity of life, profitable employment, &c. Subjects of inguinal herniæ with adherent omentum are never really safe, especially if of active life.

iii. Small femoral herniæ containing irreducible omentum. These herniæ are difficult to fit with trusses, and the omentum keeps the ring open, and thus paves the way for the descent of bowel on any sudden exertion.

iv. Large herniæ, even colossal, where the patients, unfitted for work of any kind, are a burden to themselves and others,† and perhaps willing to run great risks; for it cannot be denied that these are very grave cases: "The operation usually difficult and prolonged, and the dangers to be met and overcome both numerous and various" (Banks). The best proof of this is given by Mr. Banks' series of 16 very large and enormous herniæ; of these he lost 4, 2 from septicæmia. In another, even his hands failed to complete the operation.

v. I consider ten to twenty-five years of age as the most favourable time, as combining parts easy to handle, the possibility of keeping the wound aseptic, probable absence of any difficult adhesions, and good vitality and health.

Choice of Operation.—The following have been brought prominently before the profession—viz.:

i. **Operation by Open Method with Strict Aseptic Precautions.**

ii. **Subcutaneous Methods**—*e.g.*, **Prof. Wood's and Mr. Spanton's.**

iii. **Injection of Astringents**—*e.g.*, **Oak Bark.**

Of these, the operation by open method will be described first and fully, as it is the one of all others which is generally chosen, owing to the excellent results which it has given, the precision with which the structures concerned can be avoided or manipulated, and its safety when aseptic precautions are strictly observed. There is no doubt that special methods, such as those of Prof. Wood and Mr. Spanton, give excellent results in the experienced hands of those who have introduced them, but it is equally certain that they have not been generally adopted. This is still more true of the injection method, in this country at least.

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* This age is mentioned above as giving time for trials with a truss. The parts too have become more developed and are now more easily kept aseptic. Before deciding that a well-made truss will not keep up a difficult case—*e.g.*, a double inguinal hernia—the hernia should be completely reduced with the aid of an anæsthetic.

† As in three cases given by Mr. Banks: one, a labourer, unfitted for work had become an inmate of a workhouse; the second was a wine-merchant, who had been obliged to give up his business, rarely venturing out, and then obliged to conceal his deformity under a large overcoat; the third, a glass-blower, reduced to perfect helplessness, had to depend on his wife for his support.

i. **The Operation by Open Method with Strict Aseptic Precautions.***—The patient having been kept in bed for some time before, according to the size of the hernia, and any cough attended to, only liquid diet is given for the few days preceding the operation, and the bowels are duly attended to.

The parts being shaved if needful, and cleansed,† the thigh being a little flexed, an incision is made with its centre over the external abdominal ring,‡ and the sac itself reached and made certain of.

The sac being defined just below the external abdominal ring, the surgeon must make up his mind how he is going to deal with it. At least the four following courses are open, and all are well deserving of trial:—

A. The sac being freed from its connections, and its contents reduced, it is ligatured close to the internal ring, and the fundus cut away. A few silver sutures are then inserted in the canal and the external ring and left *in situ*, the object of the sutures being merely to hold the parts together temporarily during healing (Banks).

B. The sac, separated not only from the inguinal canal, but also from the inner surface of the internal ring, is reduced into the abdomen so as, bulwark-like, to protect the ring.§ While this is the primary point, the canal and external ring are most carefully closed with sutures (Macewen).

C. The neck only of the sac being freed (the fundus being left *in situ*), this is tied and divided. The stump is then pushed up into the abdomen, while the rings and canal are closed (Barker).

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* The following remarks apply to inguinal hernia.

† Dr. Macewen (*loc. infra cit.*) recommends scrubbing with a nail-brush and soap and water; after drying, turpentine, to remove any grease, and then a little methylated spirit to clear away the turpentine, the parts being then covered with lint soaked in some aseptic solution.

‡ Mr. Kendall Franks advises that when the incision above is made parallel to the canal, the skin should be drawn down. Thus the skin-wound does not correspond to the sutures buried beneath, and is further removed from sources of sepsis.

§ See p. 670.

D. The sac, being freed quite up to and around the internal ring, is twisted, and, the fundus being cut away, the twisted stump is secured *in situ* by sutures passed through the external abdominal ring (Ball).

A. *Method of Banks.*[*]—The sac, having been made certain of, is separated from the cord with a finger or steel director, the vas deferens being taken as a guide. This defining of the sac, and its separation, are often matters of difficulty—in children, owing to the delicacy of the parts and the minute size of the constituents of the cord, and in adults from the closeness of the adhesions. The surgeon may easily think he has reached the sac long before he really has. In this way the parts may be needlessly interfered with and stripped off, and, owing to oozing into opened-up areolar spaces, landmarks are lost, and suppuration and even sloughing may occur.

Care must be taken not to drag the testicle out of its bed. In congenital cases, to avoid needless disturbance, the sac, when separated, should be cut through above the testis, and this part sutured to form a tunica vaginalis.[†] The sac is next separated, through the external ring, up into the canal as high as the internal ring, the finger keeping note, all the time, of the position of the cord. If the sac is clearly empty, its neck is now ligatured with stout chromic gut or carbolized silk as high up as to leave no neck, orifice, or dimple at the internal ring. The fundus is then cut away about ½ inch below the neck.

If there are any doubts about the sac being empty, a small opening is made, and the little finger introduced to make certain.

If it be needful, owing to adhesions of intestine or presence of altered omentum, the sac must be freely opened, adhesions separated, and the omentum tied[‡] and cut away as directed at p. 644, and returned.

While the omentum is being examined and dealt with, an assistant must keep a finger carefully on the canal above, to prevent any slipping upwards before all is ligatured, otherwise grave hæmorrhage may occur.*

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[*] See foot-note, p. 664.

[†] A running suture of chromic gut may be used here. I employed this in two cases in 1887 in a child of five and a man of twenty-two, and, on account of the possibility of hydrocele, watched these artificial tunicæ vaginales with much interest for some months.

[‡] If the surgeon is in doubt about returning any stumps of omentum, he should retain these in the canal by his sutures passed through this and the pillars. It will render the fitting an ordinary truss more difficult, but not one with a horseshoe pad, and will ultimately shrink and blend with other tissues. Even if this is delayed, it would be preferable to setting up peritonitis by returning any doubtful omentum.

The next step is the suturing of the rings and canal. While, no doubt, securely ligaturing the neck of the sac as high up as possible is the first point, when this is effected, the above structures should be as carefully sutured as possible, if time and the condition of the patient, &c., admit of it. As might be expected, the materials used are various—viz., wire, carbolized silk, chromic gut, and kangaroo tendon. Mr. Banks uses silver wire† so thick that a single knot on it will suffice to make it hold without any second knot and without any twisting. The wire should be cut very close to the knot, so as to leave no projecting sharp ends.

Chromic gut is a little uncertain, in some cases soon softening, in others coming away but little changed, with points of suppuration.‡ Carbolized silk is, on the whole, the most generally applicable, the twisted, not the plaited, kind being made use of.§

The surgeon's chief object in passing the sutures should be to bring the conjoined tendon as close to Poupart's ligament as possible, at a point as near the internal ring as may be, so as to make the canal again a mere chink or valve instead of a short, wide tunnel.

With a curved needle on a handle (Fig. 113) or one in a holder, the finger-nail being insinuated under the edge of the conjoined tendon on the outer side of the rectus abdominis, the needle should be passed so as to take up the tendon and the external oblique aponeurosis overlying it; the cord being then felt for, found, and pushed upwards and inwards, the needle is then passed through Poupart's ligament as near the centre as possible. In passing this highest and most important suture care must be taken to avoid the deep epigastric, the cord, and the iliac vessels. Other sutures‖ are then passed (1) through the conjoined tendon and external pillar; and (2) through the pillars of the external ring. Before any sutures are tied the cord should be examined and found free.

Drainage is now provided with a bundle of horsehair, and the skin wound closed with silk sutures. The dressings, iodoform and sal-alembroth gauze, are applied as at p. 646.

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* This precaution will also meet any vomiting and re-descent of the intestine.

† "Its hold is certain and enduring beyond that of any other suture, while it is as harmless as any" (Banks, Pamphlet, pp. 13, 14).

‡ If this is used, it should be taken from a sample which the surgeon has tested in operations, and the final soaking should be under his eye.

§ Note, p. 457.

‖ Three, at least, if possible, in a large hernia.

B. *Macewen's** (Fig. 113).

The object of this is twofold: (1) So to separate the sac as to allow of its being completely reduced into the abdominal cavity, there to rest on the inner surface of the circumference of the ring, and as a bulwark-like pad to "shed the intestinal waves away" from it.† (2) By a particular mode of inserting sutures to bring the conjoined tendon in close connection with that part of Poupart's ligament which is on a level with the lowest part of the internal ring.

The first object is thus ensured:—The external ring being exposed (after the preliminaries, foot-note, p. 667), the internal ring and site of the deep epigastric are examined, and the sac next freed and raised. When this is done, it is kept pulled down while the index finger separates the sac from the cord, the canal, and finally for ½ inch around the abdominal aspect of the internal ring.‡ The sac is now folded on itself (Fig. 113) by means of a stitch which is firmly fixed in the distal end of the sac. The free end, threaded on a needle, is introduced through the canal to the abdominal aspect of the fascia transversalis, and there penetrates the abdominal wall about 1 inch above the internal ring. The wound in the skin is pulled upwards so as to allow the point of the needle to project through the muscles without penetrating the skin. The needle being withdrawn and unthreaded by traction on the thread, the folded sac is drawn still further backwards and upwards. Traction having been kept up on the thread while the sutures are introduced, it is finally secured by passing it several times through the external oblique muscle.

The second part of the operation, closure of the inguinal canal (Fig. 113), is now undertaken. The finger, passed into the canal and lying between the inner and lower border of the internal ring in front of and above the cord, makes out the position of the deep epigastric artery so as to avoid it.

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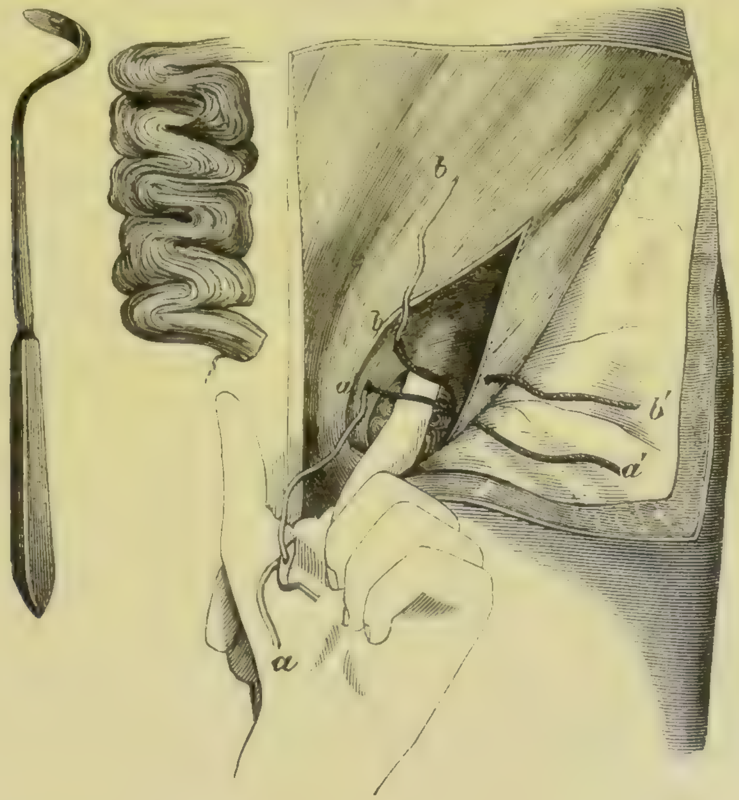
* *Ann. of Surg.*, August 1886; *Brit. Med. Journ.*, December 10, 1887, with nine woodcuts.

† Dr. Macewen thinks that, however carefully and high up the sac is tied, there remains a funnel-shaped puckering, the apex of which presents in the internal ring, and that this pouch gradually becomes a wedge, tending to open up the canal.

‡ All this is done through the original small incision, "sufficient to expose the external abdominal ring."

The hernia-needle, carrying chromic gut, then, guided by the index, is made to penetrate the conjoined tendon in two places, first from without inwards (*a*) near the lower border of the conjoined tendon, and secondly from within outwards, as high up as possible in the inner aspect of the canal (*b*), this double penetration of the conjoined tendon being accomplished by a single screw-like turn of the instrument. One end of the suture is then withdrawn, and then the needle, with the other end, is removed. Thus, a loop is left at the abdominal aspect of the conjoined tendon.

FIG. 113.



On the left is one of Dr. Macewen's needles. They are made of one piece of steel. In the middle is the folded sac. The right-hand figure (modified from those of Dr. Macewen) is intended to show his mode of suturing the internal ring. The index finger in front of the folded sac is separating the peritonæum round the internal ring. The suture *a*, *b*, has penetrated the conjoined tendon at two places, first from without inwards near its lower border, and secondly from within outwards, as high up as possible, a loop being thus left on the abdominal aspect of the conjoined tendon. At *a′* and *b′* the two ends of the above suture have been passed, separately threaded on needles, from within outwards, through Poupart's ligament below, and through the transversalis and obliques above.

Secondly, the other hernia-needle, threaded with that part of the suture which comes from the lower part of the conjoined tendon (*a′*), guided by the index in the inguinal canal, is passed, from within outwards, through Poupart's ligament, which it penetrates at a point on a level with the lower suture in the conjoined tendon. The needle is then completely freed from the suture and withdrawn.

Thirdly, the needle, now threaded with that part of the catgut which protrudes from the upper border of the conjoined tendon (*b′*), is passed from within outwards through the transversalis and internal oblique muscles and the aponeurosis of the external oblique at a point on a level with the upper stitch in the conjoined tendon. It is then quite freed from the suture and withdrawn. There are now two free ends in the outer surface of the external oblique, continuous with the loop of the abdominal surface of the conjoined tendon. The two free ends being drawn together tightly, and tied as a reef-knot, the internal ring is firmly united. The same stitch may be repeated lower down in the canal, especially in adults, with wide gaps. The pillars of the external ring may likewise be brought together. In the great majority of cases the first or uppermost stitch is all that is required. The cord should lie behind and below the sutures and be freely movable in the canal. It is advisable to introduce all the sutures before tightening any of them. They may then be experimentally drawn tight while a finger is introduced into the canal to learn the result. During the operation the skin is drawn from side to side to bring the parts into view. The skin falling into position, the wound is opposite to the external ring, the operation being partly subcutaneous. While it is extremely difficult to criticize any work done by Dr. Macewen, and while his statistics quoted at p. 665 show what excellent results this method gives in his hands, I cannot but fear that, if much used by others of necessarily less experience, there is a great risk of deep-seated cellulitis being set up during the separation of the sac within the internal ring, and of this region (always a feeble one) being much weakened by pushing the sac through it.*

C. *Barker's.*†—This operation is similar to the above in that the sac is fixed by a suture to the internal ring, but differs from it and all others in the fact that the scrotal portion of the sac is left *in situ*. The rings and the canal are carefully closed with sutures.

The neck of the sac being exposed‡ and cleared, with all due care of the cord, two stout silk threads are now passed round this close to the external ring, precautions being taken not to include the cord, or any intestine or omentum. The threads being tied, the sac cut across between them, and the scrotal portion left *in situ* tied and with its ligature cut short, one of the upper threads on the neck of the sac threaded in a Lister's needle is passed up the inguinal canal, in front of the vas, and guided by the left index, which pushes the sac before it and feels for the inner aspect of the abdominal ring. Here the needle is passed through one border of the ring and out through the external oblique. It is again unthreaded and withdrawn, and carrying the other thread is passed up the canal and then through the opposite side of the ring and the external oblique. When these threads are knotted securely the stump is withdrawn within the abdomen, and the internal ring is also closed. Three or four more sutures are then passed through the canal and external ring. Two Russian surgeons (*Ann. of Surg.*, August 1889, p. 141) praise Mr. Barker's method highly. From an experience of eleven cases they speak of it as actually radical, and characterised by simplicity and safety.

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* In a letter to me Dr. Macewen claims that his statistics (p. 665) proved that his method is far more radical than that by ligature of the sac. Of cases passing through his own hands this is certainly true.

† *Brit. Med. Journ.*, December 3, 1887; *Man. of Oper. Surg.*, p. 334, fig. 51.

‡ The incision is represented as exposing both rings and the canal.

D. *Ball's* (*Brit. Med. Journ.*, December 10, 1887).—Here the sac is twisted, the fundus cut away, and the stump stitched in the ring.

The sac being completely isolated right up to the internal ring, and ascertained to be empty, is gradually twisted up by a broad catch-forceps grasping its neck, while the left fore-finger frees the upper part of the neck.* In ordinary cases, four to five complete revolutions are sufficient, but this must depend on the thickness of the sac, the torsion being continued till it is felt to be quite tight and likely to rupture. An assistant, now holding the torsion-forceps, maintains the twist, while a stout catgut ligature is tied tightly round the twisted neck and cut short. Two sutures of stout aseptic silk are now passed through the skin about ½ inch from the edge of the wound, through the outer pillar of the ring, through the twisted sac in front of the catgut suture, and then through the inner pillar and skin. As the sac now cannot untwist it is cut off in front of these sutures, which are tied over leaden plates, lying at right angles to the wound. From investigations on the dead body, Mr. Ball finds that the result of the above procedure is to throw the peritonæum into a number of special folds, radiating from the internal ring in all directions.

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* Where the hernia is congenital, the sac must be cut through first above the testicle, and then twisted. In those rare cases where it is impossible to separate the sac from the cord, this method would be impracticable.

The ring, instead of being depressed, is rendered more prominent than the neighbouring peritonæum. From an experience of this method in eleven cases I would recommend it very strongly on account of its extreme simplicity and its good results.

Subcutaneous Methods—*e.g.*, **those of Mr. Wood and Mr. Spanton.**—Successful as these have been in the hands of their authors they have never been largely adopted by surgeons. Important, no doubt, as is the subcutaneous principle in surgery, there is a wide difference between it when applied to division of tendons, and to the taking up with wire or corkscrew enough of important parts to ensure a good result, while at the same time other most important structures—*e.g.*, peritonæum, vessels, and cord—must be left untouched. The difficulty of making sure of enough inflammation, adhesion and consolidation, the feeling that a certain amount of suppuration is needful to ensure loosening and removal of the wire or corkscrew, and that this suppuration may lead to serious results, while the having to remove a foreign body may break down much of the good done, are, it seems to me, powerful objections.

iii. **Injection of Astringents.**—I am unable to find space for an account of this method. The full account given of the open method will, I believe, meet all cases. That by injection has found no favour amongst English surgeons.

RADICAL CURE OF FEMORAL HERNIA.

There is very much less necessity for this, women, in whom it is so much more frequent, finding a truss more efficient and less irksome, owing to their less active life and mode of dress. Omental femoral hernia (p. 666) should be operated on when there is the least difficulty in fitting, or unwillingness to wear, a truss, the sac being always ligatured and taken away. The same course should be followed in all cases of strangulated femoral hernia, when the condition of the patient admits of it, care being always taken to make the smallest nick possible in Gimbernat's ligament, so as to minimize the risk of recurrence. The steps have been already given at p. 646.*

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* Two of my reviewers, who stated that I had given no operation for the radical cure of femoral hernia, must have overlooked the account given above.

RADICAL CURE OF UMBILICAL HERNIA.

This operation is very rarely called for in children as the tendency to a natural cure is so marked.

In those rare cases in children where the operation is justifiable from the large size of the ring, and the want of improvement under the surgeon's own eye, the ring should be closed, with strict aseptic precautions. To such cases an operation of Mr. Keetley's (*Ann. of Surg.*, September 1887) is well adapted. The sac being separated and twisted, as in Mr. Ball's method (p. 673), a stout catgut suture is passed through it, and the peritonæum being very carefully separated from the linea alba above the ring, a needle is passed up into the space thus made, carrying the catgut, threaded, through the sac, and brought out through the linea alba. Then, on pulling the catgut tight, the twisted sac is drawn into the space between the peritonæum and the linea alba. The edges of the hernial aperture, now freed, are pared and brought together with pins and twisted suture.

For those cases of adult umbilical hernia where the age, and the condition of the patient as to her lungs and other viscera is sufficiently favourable, and where a truss or belt is found useless, the operation already given (p. 659), and the steps for taking away the sac and redundant skin, and suturing the ring, will be found sufficient.

CHAPTER III.

COLOTOMY.

UNDER this term are included the operation of opening the ascending or descending colon in the loin, or lumbar colotomy—an operation with which the name of Amussat * is justly associated—and also the anterior colotomy of Littré, in which the sigmoid colon is opened in the left iliac region.

Colotomy will be compared with excision of the rectum, in cases of cancer, later on.

LUMBAR, OR POSTERIOR COLOTOMY (Figs. 114, 115).

Indications.

(1) Malignant disease of rectum not admitting of dilatation.

(2) Venereal, or syphilitic stricture of rectum, in which previous treatment, including dilatation, has failed, and in which proctotomy† is not available.

In either of the above, extensive ulceration, much pain,‡ loss of sphincter power, profuse blood-stained or fæco-purulent discharge from the bowel or multiple fistulæ, abundantly justify the operation.

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* Students are often perplexed as to the difference between Amussat's and Callisen's operations. Callisen (1796) was the first to suggest such an operation as colotomy, and planned to open the descending colon by a vertical incision. This proposal was condemned by contemporary surgeons. Amussat revived the retro-peritonæal operation, if he was not the first to perform it, but modified it by extending it to the ascending and descending colon alike, and by making use of the transverse incision. Long before Amussat's time, Littré (1710) had opened the sigmoid flexure through the peritonæum, and in 1776 Pilloré had opened the cæcum.

† Linear division of a non-malignant stricture posteriorly. If a finger cannot be passed through the stricture, this is first divided with a probe-pointed bistoury to admit the finger. Then a curved, sharp-pointed bistoury, passed through the stricture, is made to transfix the bowel beyond the stricture, and the point is brought out close to the tip of the coccyx. The parts are then cleanly divided by cutting out towards the anus in the middle line. In about ten days the use of bougies is commenced. For a good account of this excellent operation, see Mr. Cripps' *Dis. of the Rectum and Anus*, p. 239.

‡ In a few and exceptional cases cancer of the large intestine may run its course, set up visceral deposits, and kill the patient with very little pain. In many others simple means, if used regularly, *e.g.*, attention to diet, laxatives, washing out the bowel with warm water two or three times a day, followed by

It is in such cases as those where the symptoms are not yet very urgent that the surgeon will find most difficulty in deciding when to advise colotomy. Where intestinal obstruction* is actually impending, the patient will be anxious to submit, owing to the amount of pain and distress actually present, and the surgeon will be ready to perform an operation, even if the duration of life may be but brief. In less urgent cases if the surgeon be doubtful as to recommending this operation, he cannot do wrong if he lay stress on two points, one, that there is always the risk of obstruction setting in, and none can say how soon this may call for colotomy under circumstances much less favourable ; the other that there is great hope that the operation by diverting the fæces will arrest the rate at which the growth will otherwise spread.† In these same less urgent cases, the patient or the friends, especially if in a better rank of life, will frequently expect a decided answer as to the amount of relief, and also the amount of annoyance which will follow on an artificial anus. Before attempting to give any data on which an answer may be founded, I would say that I think the more frequently a surgeon performs this operation the more will he admit that there are cases, occasional no doubt, in which this operation, though well performed, fails to give the expected amount of relief.

Putting aside cases where the operation is performed too late, and where the local mischief has been allowed to become too advanced, those where secondary deposits exist, cases where the opening has been too free, or where, with a proper opening, a

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a suppository of cocaine and iodoform with morphia and belladonna, an astringent injection being given if needful, and retained at night, will give much comfort, at all events for a time. When these fail, or when obstruction begins to appear in the distance, colotomy should be resorted to unless age or such conditions as ascites, secondary deposits in the peritonæal or thoracic cavity render this step unadvisable.

* The importance of this, its presence or absence, is well-known. It is due to procrastination, which puts off colotomy till the strength is exhausted by repeated attacks of obstruction, and peritonitis is setting in that the statistics of this operation are not more favourable. Mr. Bryant in his Bradshaw Lecture on Colotomy, states that of 100 cases in which he operated to relieve obstruction, 55 were successful, of 70 cases operated on before obstruction threatened life, not one sank from the operation.

† Sometimes this is as marked as it is unexpected. I am now (February 1891) watching the case of a young woman in whom I performed lumbar colotomy in April 1887, for a soft bleeding carcinoma of the anterior wall of the rectum. The rectum has long been entirely occluded, but the general health is only now beginning to fail.

constant cough, aided by a relaxed condition of tissues, tends to bring about a worrying prolapsus, putting aside cases in which the opening was perhaps originally too small, or in which the patient does not take the trouble to keep the opening dilated as directed, I am of opinion that occasionally causes of failure to give complete relief are met with after an operation quite properly carried out. While I cannot give, and have failed to meet with, an explanation for every case, I think the following are *bonâ fide* causes, and without detracting seriously from the value of this excellent operation, because only occasional, I feel that they have been somewhat unduly overlooked, and that there is too great a tendency amongst writers on colotomy to teach that, if it is done sufficiently early, and if its immediate risks are survived, the relief is *always* decided and the patient's condition *always* a most satisfactory one.

Some of these instances of incomplete relief—viz., persistent passage of motions over the malignant disease, and teasing diarrhœa from the artificial and natural anus, have seemed to me to be due: (1) To the lower communication with the bowel being too patent, sometimes no doubt accounted for by the fact that the colon at the spot where it has been drawn into the wound, owing to the shallowness of the loin or the length of the meso-colon, is scarcely kinked or bent at all; this leads to escape of fæces over the malignant growth and much pain and teasing diarrhœa. (2) To persistence of the growth in the bowel below, causing a profuse sanious discharge. (3) To the growth extending upwards towards the wound, or to the bowel having been opened only just above the growth.

As a rule, the more complete the failure of previous treatment, the more painful, difficult, frequent, and unsatisfactory the action of the bowels, the greater the tendency to distension of the sigmoid or lower intestines generally, the more frequent the attacks of gripings and partial obstructions, which herald in the tormina of a complete *miserere;* the younger the patient, and thus the longer the natural prospect of active life, the more plain are the indications for colotomy. On the one hand, certain special evils* call loudly for the relief which the operation may give—viz., a patulous or invaded sphincter allowing of involuntary escape of flatus and fæces, multiple fistulæ giving rise to foul sanious discharge, keeping the patient (perhaps a woman of scrupulous cleanliness) in a constantly filthy condition, and leading to a brawny, painful condition of the buttocks, which thus readily become the seat of cellulitis and its allies; projection of the growth downwards through the anus, leading not only to a patulous sphincter and its consequent wretchedness, but also to irksome or painful sitting.

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* To quote only two special wretchednesses—*e.g.*, when a lady cannot rise from her easy-chair without an escape of flatus or fæces taking place from a powerless sphincter, or when a man is threatened with agonies of pain from the carcinoma eating backwards and involving the sacral nerves, and causing caries of the sacrum, with fistulæ and foul discharge.

The above passage stands as I wrote it in the first edition of this book. I am glad to be able to confirm its correctness by the opinion of a surgeon of wider experience than my own, Mr. Jessop of Leeds (*Brit. Med. Journ.*, 1889, vol. ii. p. 408). "A careful and impartial comparison of their sufferings, however, in a series of patients, including some who had declined and some who had undergone operation, has convinced me of the great utility of colotomy, and has completely dispelled my doubt as to its alleviating power. The conclusions I have been able to draw are that, by its means, the continuous pain is lessened in severity; the desire to evacuate, almost constant, and very distressing where no operation is performed, disappears in some and is lessened in others; incontinence of fæces, a frequent source of anguish in rectal cases, though occasionally met with, is usually absent in the colotomised; and finally, the motions are not only discharged with comparative ease, but in the majority are reduced to at most two or three in the twenty-four hours."

On the other hand, certain conditions contra-indicate the operation—viz., exhaustion of strength, evidence of secondary deposits in the peritonæal cavity, liver, lungs, or pleura, absence of much pain or obstruction from first to last.

(3) Annular stricture of the sigmoid colon.

(4) Malignant disease of the large intestine higher up—viz., in the splenic or hepatic flexures.

(5) Pelvic tumours pressing on the rectum.

(6) Results of pelvic cellulitis narrowing the rectum.*

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* This, though rare, is occasionally an undoubted indication for colotomy. I still see from time to time a woman in whom Mr. Howse, over ten years ago, performed colotomy for urgent obstruction due to the contraction of the bowel brought about by pelvic cellulitis. Quite lately I have had under my care a woman, aged twenty-three, in whom chronic obstruction had been brought about by the same cause, dating here to the birth of an illegitimate child. The ring of contraction round the rectum was here so marked, that carelessness in diet or neglect of the use of bougies will, I am certain, lead to colotomy being ultimately called for. The possibility of the mischief in these cases being gummatous must always be remembered.

(7) Chronic intestinal obstruction due to any of the above causes.

Mr. Jessop (*Brit. Med. Journ.*, 1889, vol. ii. p. 407) shows that the position of the cancer has a most important bearing on the onset of obstruction. Thus, in cancer of the lower half of the rectum there is not much need to fear the occurrence of complete obstruction: on the other hand, this is almost certain to appear sooner or later when the upper part of the rectum is involved. Mr. Jessop explains this difference by the anatomical relations of the two parts. Thus, whereas the lower part of the rectum becomes more closely applied to the sacrum and pelvis, in its upper part it is comparatively free. Therefore, with cancer below, the contractile action of the colon above is exerted with effect in forcing the contents through a contracted ring where that ring is fixed and immovable; on the other hand, with cancer of the upper rectum, the narrowed portion is free, movable and not attached, the efforts of the bowel above succeed only in invaginating or otherwise displacing the growth, often so as to bring it within reach of the finger, but fail altogether in effecting any onward movement of its contents.

(8) Vesico-intestinal fistula.

Lumbar colotomy is performed in cases of communication between the large intestine, especially the rectum, and the bladder, to prevent the passage of fæces into the bladder, with its results of cystitis, agonizing obstruction of urine, and passage of flatus from the urethra without notice and beyond control.

Such a fistula is much more frequently met with between the sigmoid or rectum and the bladder; if between the latter and the rectum the communication may be found by the finger, or by passing a duck-bill speculum and injecting coloured fluids.* Too frequently malignant in character, it is occasionally of a simpler nature—*e.g.*, dysenteric, &c., and so, perhaps, curable. Thus, in Mr. Holmes's case (*Med. Chir. Trans.*, vols. xlix. and l.) the ulceration between the sigmoid and the bladder was not malignant, colotomy for fifteen months was most successful, but a permanent cure was prevented by similar ulceration taking place between the cæcum and bladder which caused death. Whether the cause is malignant disease or no, the life which lies before the patient is scarcely tolerable.

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* The following plan, based upon one made use of by Mr. Lund (*Hunt. Lect.*, 1885, p. 91), would very likely be useful—viz., to pass into the rectum a bougie, round which is wound a strip of lint well soaked in starch and water and dried, and then to inject into the bladder some diluted iodine solution. A stain of starch iodide on the bougie would show the position of the fistula.

The opening is far more frequently valvular in nature—*i.e.*, while it admits of the passage of fæces into the bladder, urine very rarely passes per anum.

Some *rarer indications for colotomy* deserve mention, viz.—

(9) Cancer of the tail of the pancreas obstructing the splenic flexure. Mr. Beck records a case of this kind (*Lancet*, vol. i. 1887, p. 113). When the descending colon was opened neither gas nor fæces escaped, although the abdominal tension caused the gut to protrude through the wound. The finger inserted into the colon could not reach the seat of obstruction. The ascending colon was accordingly opened, and a large quantity of pus and liquid fæces at once escaped. The operation gave great relief, but death (unexplained by the autopsy) took place suddenly seventeen days later.

(10) Malignant disease of the prostate when the chief symptom of this is rectal and not vesical obstruction.

Site of the Proposed Colotomy.—In some cases, especially where intestinal obstruction is threatening from malignant disease, the surgeon may be in doubt as to the site of the disease, and therefore on which side to operate. It is quite impossible to make fixed rules for advice, but the following points will help in doubtful cases. Before specifying them I would call attention to two points, one, that malignant disease quite low down—*e.g.*, sigmoid, may, by a sudden onset of obstruction, simulate a more acute condition of things higher up, the patient being too ill, or otherwise unable to give an account of previous culminating obstructions, and that thus the abdomen may be opened, while all that is wanted is a lumbar colotomy; the other, that in all cases of doubt the colon should first be explored in the loin, preferably the right. The other alternative, if the site of the obstruction cannot be determined, is to open the abdomen in the middle line and explore from here. When the patient's condition is good, and the abdomen not distended, when the surgeon is well versed in peritonæal surgery and has skilled helpers, this course will not add materially to the risk. But where the case is urgent and the abdomen distended, it will be the safer course, in cases of chronic obstruction where the site of the block cannot be ascertained, to explore the ascending colon at once.

(1) The proportionate *frequency of stricture in different parts of the large intestine.* The frequency of disease in the rectum and sigmoid flexure, as compared with any other part of the large

intestine, and, generally speaking, the frequency of disease in the left side of the arch formed by the large intestine, as compared with such disease in the right side, are well known.*

(2) *The Use of Large Injections.*—Dr. Fagge (*loc. supra cit.*, p. 318) thus writes on this subject: "Several writers, and especially the late Dr. Brinton, have laid stress on the value of large injections as an aid to diagnosis. The observer I have named has even laid down definite rules for our guidance in this respect. 'It is quite singular,' he says, 'how trustworthy I have found the conclusions thus arrived at. For example, with a maximum injection of a pint of warm, bland liquid, the obstruction in an ordinary male adult may be referred to a point not lower than the upper third of the rectum. A pint and a half, two pints, three pints, belong to corresponding segments of the sigmoid flexure. The descending and transverse colon accept a larger, but more irregular quantity. In one case, in which it was evident that the stricture occupied the upper part of the ascending colon, nine pints of injection were always found to be the maximum.'" Dr. Fagge points out that the correct determination of this point requires much care, as (*a*) some of the fluid measured may escape in the injection; and (*b*) a stricture may be pervious to fluid injected from below, though the intestinal contents may be unable to pass through it from above. Thus, in a case in which there was a mass of disease in the sigmoid flexure, just above the pelvis, four pints of water were injected per rectum; of this a small portion only returned, the greater part passing through the stricture and adding to the accumulations above it. I would add one more caution with regard to these injections. Patients, in much misery, and having submitted to one or two rectal examinations, will sometimes ask for an anæsthetic. Such an aid must be used with great caution if there is already abdominal distension. There is not only a danger of adding seriously to the distension, and thus further weakening or rupturing parts which may be already near the point at which they give way—*e.g.*, a cæcum with "distension ulcers"—but an anæsthetic, especially chloroform, has additional dangers in such cases as these, where, in a patient probably no longer young, the action of the heart and lungs are interfered with by the upward pressure

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* Dr. Fagge, in drawing attention to this fact (*Guy's Hosp. Reports*, 1868, p. 314), quoted the following statistics from Dr. Brinton:—"Of 100 cases, 4 are in the cæcum, 10 in the ascending colon, 11 in the transverse colon, 14 in the descending colon, 30 in the sigmoid flexure, and 30 in the rectum." The statistics of Dr. Fagge and M. Duchaussoy confirm the above.

against the diaphragm. The vomiting, which the anæsthetic may cause, may also prove suddenly fatal, fæcal matter being sucked down into the lungs.

(3) *The distance to which a long bougie or rectal tube passes* is of very little value, and needs only the briefest mention here, because the surgeon is still called to cases in which he is assured that the obstruction cannot be in the rectum or low down in the sigmoid flexure, as a long bougie has been easily passed its full length. This fallacy, which is due to the bougie bending on itself, is more frequent than the other one, in which the arrest of a bougie by one of Houston's folds misleads into the belief that a stricture exists low down.

(4) *The form of the abdomen* may give valuable conclusions. Thus Dr. Fagge (*loc. supra cit.*, p. 319) gives a case of cancer of the hepatic flexure, in which it was observed during life that the cæcum and ascending colon were distended, and not the descending colon. Again, he observes that when the rectum or the sigmoid flexure is the seat of obstruction, the lumbar regions and the epigastrium are no doubt generally prominent, and the course of the colon is more or less plainly marked out. That these conclusions are only valuable if not too implicitly relied upon is shown by the fact that cancer of the rectum may be present, with vomiting, peristalsis, and borborygmi, and yet there may be no general distension of the abdomen, no filling out at all of its sides: on the other hand, a prominent epigastrium, and the appearance of a large horizontal coil of intestine here may lead to the conclusion that the transverse colon is distended, the disease being, nevertheless, in the ileum, a distended coil of which has rivalled the colon itself.

(5) A symptom of some value, if verified by the medical man himself, is the fact that for some time the *motions* have been *narrow, tape-like, broken up, abnormal in bulk, shape, and length.* Certain fallacies diminish, however, the value of the above—*e.g.*, that in cases of stricture high up, as in the upper part of the sigmoid flexure, there is probably room for the fæces, after they have got through the stricture, to collect, till their characteristic form is given them, though we do not know how far irritation of the intestine and formation of mucus at the seat of the growth may interfere with this.

(6) A few other points—*e.g.*, constant *arrest of borborygmi at one spot*, *fixed pain at one spot*, as in the right hypochondrium—may give useful indications, while others, such as a *rectal examination,* are so obvious as scarcely to need mention.

If, after weighing the above, the surgeon is still in doubt as to the exact site of the disease of the large intestine, he should not hesitate to perform right-sided lumbar colotomy. He should not be deterred from this by the anatomical difficulties (*e.g.*, a more complete peritonæal coat) supposed to exist on this side. Especially where the colon is at all thickened or distended, the operation on one side is no more difficult than on the other.

Landmarks (Fig. 114).

1. The lower border and tip of the last rib.

2. A point ½ inch behind the centre of the crest of the ilium, this point being found by accurate measurement along the crest between the anterior and posterior superior spines (Allingham).

3. A line drawn vertically up from the last-mentioned point to the last rib. This gives, with sufficient correctness, the line of the outer edge of the quadratus, and the position of a normal colon.

Owing to the varying length of the last rib, the upper end of this line may meet this bone at its tip, or at a spot a varying distance in front of or behind this point. It is well to dot the ends of this vertical line with an aniline pencil. The dint of a finger-nail, made when the patient has been brought under the anæsthetic, will mark these points sufficiently to begin with, but a little later, in a difficult case, the surgeon may be glad of having taken every possible precaution.

Incisions.

1. Vertical, of Callisen. This at first sight is the best, as it follows the above line, and thus corresponds anatomically to the colon, but it has the disadvantage of giving but limited space, especially in a fat or deep-chested patient; and, if prolonged upwards, so as to give all the space possible, it divides the intercostal vessels running with the last dorsal nerve, and gives rise to troublesome hæmorrhage.

2. Transverse, of Amussat.

3. Oblique, of Bryant, modified from the above. One of the two latter is usually employed; they have the great advantage of being readily prolonged when more room is required, and the oblique incision corresponds better with the course of the nerves and vessels.* It is the one given below.

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* Mr. Greig Smith (*Abdom. Surg.*, 3rd ed. p. 455) thinks that this incision helps to prevent prolapse of the bowel by lying almost transverse to its axis. He gives also the following practical hint:—"In thin patients, and particularly in women, whose iliac crests are more prominent than in men, there is a tendency for the upper lip of the wound to fall inwards, while the lower lip protrudes. This may

Operation (Figs. 114, 115).

The patient being turned on to his side (most usually the right), with a firm pillow under the loin, the parts cleansed, the tip of the last rib and the point on the crest of the ilium, as given above, being dotted with an aniline pencil, an incision is made, beginning 2½ or 3 inches from the spine, according to the size of the erector spine, a little below the last rib, and running downwards and forwards for 3½ to 4 inches towards the anterior superior spine. The centre of this incision should bisect the line given at p. 684 as the line of the colon.

The first cut should expose the muscles, the skin in the posterior half being thick, and the subcutaneous fat often abundant. The next may go well into the muscles, the remainder of which should then be carefully divided with the knife, or divided on a steel director, so as to expose the fascia lumborum; any bleeding vessels being now secured, this fascia is pinched up, nicked and slit up on a director. Two retractors being placed on the lips of the wound, the fat which lies around the kidney and behind the fascia lumborum is next torn through with two pairs of dissecting forceps. If the bowel is distended, it will bulge up into the wound, pushing before it the transversalis fascia, and the operation can be readily completed. If, on the other hand, the bowel is empty, the real difficulties of the operation only begin at this stage. The wound being well opened, the kidney, if it come down below the rib (as it occasionally does, especially in a patient breathing heavily under the influence of an anæsthetic), being kept out of the way by the finger of an assistant, the intestine is sought for by scratching with a director, or two pairs of forceps, through the transversalis fascia (Fig. 114) exactly in the line to which attention has been already drawn. Several layers of cellular tissue may be met with here, and it is now that most of the difficulty is usually met with, owing to the operator being afraid of the peritonæum, and to his not opening the transversalis fascia with sufficient decision. Unless this point is attended to the colon cannot bulge satisfactorily, or be drawn up into the wound.

When this has been done, scybala in the colon will in many cases be felt, but if the large intestine is empty much trouble may be met with in detecting it and getting it up into the wound, especially if, close by, the peritonæum is bulging up.

At this stage the following points may be usefully remembered:

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be obviated by careful apposition, and by not bringing the line of the incision too close to the ilium."

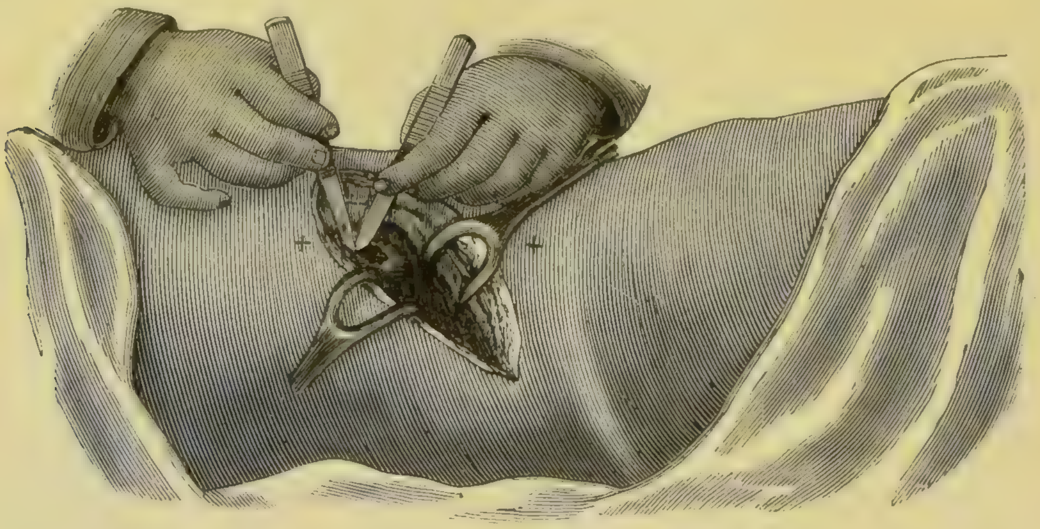
(*a*) The exact position of the line of the colon (p. 684).

(*b*) The lower end of the kidney, and its relation to the colon.

(*c*) The outer edge of the quadratus lumborum (p. 684).

(*d*) The sensation of thickness as given to the fingers in pinching up the colon, thus distinguishing large from small intestine.

FIG. 114.



(*e*) The feel of scybala if present.

(*f*) Seeing one of the three longitudinal muscular bands which distinguish the colon.[*]

(*g*) Inflation with air or injection of fluid.[†]

(*h*) Mr. Bryant has advised rolling the patient over on to his back at this stage, so that the colon may be felt to fall on the finger inserted deep into the wound.

The bowel having been found, its posterior surface is to be drawn well up into the wound, and, if the case is not an urgent one, retained there by passing long hare-lip pins through it. There is no need to pass the pins through the edges of the wound; they simply lie across these, resting on the margins of the wound at either side, a few strips of iodoform gauze being placed under them, or little slips of cork on their ends. The pins should be passed through the bowel at a distance of at least ¾ inch from each other, so as to render easy the opening of the bowel in a few days' time, and they should not, if it can be managed, penetrate all the coats of the intestine. The pins are so fine* that any puncture of the canal itself will probably give rise only to a little flatus, readily met with iodoform. The margins of the wound are then carefully closed with silver wire or carbolized silk sutures, and a few fine ones may be passed between the bowel itself and the margins of the wound. Dry gauze dressings are then applied, iodoform being dusted over the bowel and wound. These dressings will probably not need changing till the fourth day, when the operation is completed by opening the bowel with a tenotomy knife between the pins; this opening may be a small crucial one, very little but flatus will pass at the time, but a director will show the presence of fæces, and mild aperients may be given as soon as the parts are firmly healed. The above **method of performing colotomy by two stages** was introduced at Guy's by some of my senior colleagues, Mr. Bryant, Mr. Howse, and Mr. Davies-Colley, being based on that most important modification of gastrostomy which Mr. Howse was the first to make use of in this country. Mr. Davies-Colley brought before the Clinical Society (*Trans.*, vol. xviii., 1885, p. 204) a paper on "Three Cases of Colotomy with Delayed Opening of the Intestine." It was from him I learnt the use of the pins† given above. Some operators—viz., Mr. Bryant

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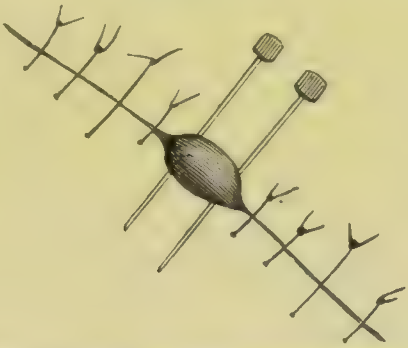
[*] Mr. H. Allingham (*Brit. Med. Journ.*, April 28, 1888) seems to consider it very difficult to ensure finding one of these bands without opening the peritonæal cavity. While I should be the last to make light of the difficulties which may beset this operation, I feel sure that few surgeons, who have had a large experience of colotomy, will agree that the above step is needful, especially if the line given by Mr. Allingham's father be strictly followed.

[†] Air is most readily made use of. It may be pumped in by a Higgenson's syringe, a Lister's hand-spray, but, best of all, by the special apparatus described by Mr. Lund (*Lancet*, 1883, vol. i. p. 588), which, by means of an elastic ring, secures air-tight contact with the anus while air is being pumped in, either as an aid in colotomy, or as a means of reducing an intussusception. In some cases of cancerous disease of the rectum it will be very difficult to introduce any nozzle for inflation beyond the disease. In the summer of 1885, when performing colotomy at Guy's Hospital in a patient, the lower part of whose rectum had been unsuccessfully excised at another hospital, I found it impossible to introduce any nozzle when desirous of inflating an empty colon.

FIG. 115.



Colotomy in two stages. The bowel is shown secured with pins at the close of the first stage.

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[*] A fine "guiding" suture of catgut may be inserted in the bowel between the pins.

[†] In six cases of colotomy which I performed in 1887, I used some pins made for me by Messrs. Downs. Their steel is sufficiently tempered to be slightly flexile, thus yielding a little, a point of much importance when the knuckle of

and Mr. Howse—have had good results after simply drawing out the knuckle and leaving it protruding in the wound without any sutures to secure it, or fixed with torsion forceps, the blades covered with drainage tube, applied with just sufficient force to hold up the intestine without causing sloughing. To apply the right degree of pressure is a matter of some difficulty, and with regard to the method of leaving a knuckle without sutures, I agree with Mr. Davies-Colley (*loc. supra cit.*, p. 209) that serious difficulties may arise from the bowel slipping back into the wound.* This is especially likely to occur in a restless patient, in cases where the wound is very deep, and where, owing to the patient's weakly condition or from suppuration taking place, the intestine does not early become firmly fixed. The great advantage of this two-stage method is that it defers the opening of the bowel till this is sufficiently adherent. (2) By this delayed escape of intestinal contents the gravity of any injury to the peritonæum at the time of the operation is very much diminished. (3) The second great trouble after colotomy, that of burrowing suppuration up and down the planes of cellular tissue, which have, of necessity, been freely opened, is done away with. The opening of the intestine being delayed, primary union to a very large extent can be secured, especially with the aid of deeply passed sutures, or of chromic gut ones cut short and dropped in, and dry dressings.

If it is necessary to complete the operation at one stage the bowel should be drawn up into the wound as much as is possible, and a few silk stitches inserted so as to shut off the surrounding cellular tissue planes from the escaping fæces. The bowel may then be opened by an incision ¾ inch long, and these cut edges also stitched to the margins of the wound. The rest of the wound is then closed as accurately as possible, the parts around the wound freely smeared with eucalyptus and vaseline, the wound dressed with this or carbolic oil, and a pad of carbolized tow, and the dressings kept in position by a many-tailed bandage, by which means they are readily and painlessly renewed.

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colon has to be dragged up to the surface of a very fat loin, and thus exerts much tension on the pins. The flat heads (Fig. 115) rest comfortably on the skin margins of the wound, without causing any ulceration.

* In one case which was under my care two years ago, in which, after drawing out a knuckle of sufficient size, I had been content to fix it with numerous very fine silk sutures, the bowel was found, on the third day, when the wound was dressed, to have slipped deeply back, owing to the above fine sutures cutting through, and very great difficulty was met with in completing the operation. The wound had here united without suppuration, but the patient had been most restless.

If the bowel is too tense to allow of its being stitched *in situ* before it is opened, it may be secured by passing a ligature first through one lip of the wound, then across the bowel and through the opposite lip, and another in the same way about ½ inch from the first, an incision ¾ inch long is then made into the gut, over these sutures, their centre hooked up into the wound, and the four halves tied on either side, a few other sutures being put in between the cut bowel and the wound. If the bowel is much distended there is always some risk of fæcal matter being forced into the different planes of cellular tissue, unless every precaution is taken to keep the knuckle well up, and to close the wound thoroughly around it.

If the bowel is full of hard scybala no attempt should be made to remove them, they may be left for a day or two till aperients can be given. At times the bowel seems so empty as to suggest a failed operation; there is no occasion to be troubled at this, the contents will pass shortly.

Difficulties in Colotomy.

1. An empty bowel.* This has been already alluded to (p. 685).

2. Mistaking bulging peritonæum for colon and opening it. This may be due to the surgeon forgetting the line of the bowel, and working deeply too far forwards; or it may take place from no fault of the surgeon, being due to the presence of a meso-colon, or to the extremely contracted condition of the colon.† It

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* It is noteworthy that the intestine may be found empty, even in obstructions of long continuance. Thus, Mr. Curling (*Diseases of the Rectum*, p. 182) writes: "In a case of carcinomatous stricture of the rectum, in which I performed colotomy, after a month's obstruction, in a woman aged forty, not only was the colon contracted, but it was actually compressed against the spine, and put out of the way by the distended small intestine, so that it was impossible to reach the bowel without opening the peritonæum. No inflammation or unfavourable symptom resulted." It would have been interesting to know whether more than one obstruction did not exist in the large intestine in this case.

† In a case in which, owing to the extreme pain during defecation, the patient had dreaded any action of the bowels, and had eaten very little, the colon was much contracted and lay far back. In trying to find it, I opened the peritonæum, and omentum protruded. A carbolized sponge was kept over the opening while the colon was found, the opening then tied up with chromic gut, and the colon not opened for four days. No ill result followed. As in supra-pubic lithotomy the peritonæum may give way during vomiting. Thus Dr. Walters (*Brit. Med. Journ.*, 1879, vol. i. p. 212) was stitching the colon to the wound when "the patient retched violently, causing the peritonæum to give way and a coil of intestine to protrude from the anterior part of the wound. This was immediately covered with warm sponges, cleansed from the feculent matter it had acquired by contact with the open colon, and returned." When, five weeks later, the patient sank from exhaustion, no trace of peritonitis was found at the post-mortem examination.

by no means always causes peritonitis. When this accident has happened, as shown by the escape of a little serous fluid, the appearance of a coil of small intestine or of omentum, the opening should be at once taken up with dissecting-forceps and tied round with carbolized silk or chromic gut, and a little iodoform rubbed round the ligature.

3. A very fat loin. This is not a very uncommon source of difficulty in elderly peeple who require colotomy. It must be met by a very free incision in which all the tissues are cut equally throughout (*i.e.*, not making a conical wound deep only in its very centre). This not only adds to the difficulty of finding the bowel, but also of retaining it *in situ* afterwards. To meet the additional tension and tendency of the gut to drag away in these cases, it must be more carefully secured by close stitching, especially if it is necessary to do the operation in one stage, every care being taken to prevent extravasation of fæces into the surrounding cellular tissue.* In fat people the surgeon must be prepared, not only for much subcutaneous but for abundant extra-peritonæal fat also, coarse, and difficult to dissect in. If, in such a case, the colon is contracted, there are few more difficult operations.

4. Presence of a meso-colon. This may be a cause of much difficulty and doubt, and render opening of the peritonæum necessary. Where this is the case, the surgeon should always defer opening the colon if possible. Mr. Jessop (*Brit. Med. Journ.*, 1879, ii. 614) mentions cases in which, owing to the presence of the above, he was obliged to open the peritonæal cavity and incise the gut through its peritonæal coat. The cut edges of the bowel, brought through the opening in the peritonæum, were stitched to the skin as in the ordinary operation. No bad effect followed. Mr. Bennet May (*Brit. Med. Journ.*, 1882, i. 940), operating on the right side, found an empty colon, "and it was only by keeping strictly in Allingham's line, and patiently searching there between the layers of a great length of meso-colon, that the intestine was reached, collapsed and empty."

5. Abnormality of colon. Every surgeon must remember cases in which the descending colon, though present, was displaced, and came down in the middle line. Occasionally part of the large intestine is actually absent. Mr. Lockwood (*St. Barthol. Hosp. Reports*, xix. 256) mentions three cases in which the colon

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* As much of the wound as is possible should be closed before the intestine is opened.

could not be found at operations; in two its absence was verified post mortem, both on the right side. One of these cases is reported fully. The following are the main points:—Owing to obstruction of the large intestine, the site of which was doubtful, it was decided to cut down on the right colon. No colon could be found, and, relief being imperatively demanded, the peritonæum was opened and a loop of small intestine drawn outside the wound. Death occurred four hours after the operation, and at the autopsy the right colon was quite absent,* the cæcum being found behind the liver in the right hypochondrium, the large intestine extending from this to the splenic flexure in the usual manner.

If the colon cannot be found, three courses are open to the surgeon—(α) To open the small intestine through the peritonæum from the colotomy incision. The objections to this step are that it is very fatal, and that there is no telling what part of the small intestine is opened. (β) To perform colotomy on the opposite side, and if the colon is here distended, to open it, in two stages when practicable. This is the course that should always be followed if possible. (γ) If no colon can be found, or if the part found is below the obstruction, the linea alba should be opened to admit two fingers to explore for the displaced colon, and, if no colon can be found, to draw up and attach a loop of small intestine, chosen as near the cæcum as possible. Or Nélaton's operation (p. 777) may be performed, this being the wiser step if the patient is exhausted by a previous prolonged operation.

6. Malignant disease at the site of colotomy. This is best met by performing colectomy in appropriate cases (p. 786), or by performing colotomy on the opposite side.

7. The kidney may be embarrassingly low.

8. The peritonæum may be so pushed back by ascitic fluid that it is impossible to open the gut without injuring the peritonæum (Pepper, *Lancet*, i. 1888, 772).

9. Cases where the operation has to be completed at once, and the colon is much distended with fæces, will give much trouble. If the fæces are fluid, the excess may be drawn off by means of a trocar, after the bowel is secured *in situ*, or the patient being turned on to his back, the fæces as they escape are washed away by careful syringing.

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* Mr. Lockwood (*Brit. Med. Journ.*, 1882, vol. ii. p. 574) explains the abnormalities of the large intestine by the fact that, during its development, it is very mobile, the cæcum occupying first the umbilical, then the left, next the right hypochondrium, and, finally, the right iliac region, abnormalities following its arrest at any part of its course.

Troubles which may be met with after Colotomy.

1. Too large an opening in the bowel. This may lead to prolapse of the mucous membrane. If this take place to a large extent it is a great nuisance to the patient, owing to the moist, excoriated, bleeding surface which results, difficult to keep up by any apparatus. Even where the opening has been small, a good deal of prolapse may take place if there is much cough, and a flaccid condition of the side.

2. Too small an opening in the bowel. This is of much less moment, as it can be readily dilated by tents.[*] Of these, laminaria are much the most efficient ; two should be inserted at a time to effect rapid dilatation. Then the opening is easily kept patent by the occasional insertion of the little finger, and by the wearing of a proper plug.

3. Teasing descent of scybala into the bowel below the artificial anus. This, which often renders a colotomy disappointing, is best met by bringing the colon sufficiently into the wound at first, and by keeping patent an adequate opening. If scybala still find their way down, the colon may be washed out from the anus or the wound. If these fail, the only course, and one not devoid of risk, is to open up the wound, to divide the bowel, and attach the upper end in the wound, and then to ligature the lower end and drop it in.

Causes of Death after Colotomy.

1. Peritonitis. This may be due to the operation directly, or more indirectly from fæcal or purulent retro-peritonæal extravasation, or from septicæmia. Often it is not due to the operation, but to the want of it at an earlier stage. Thus, the distended bowel may have given way just above the obstruction ; often it is that weak spot the cæcum which is found perforated after the stress of distension.[†]

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[*] These should, of course, be secured when *in situ*. If, however, the surgeon finds that a tent has accidentally slipped into the colon, he need not fear any disaster. This accident happened in two of my cases, owing to the dressers not having taken efficient steps to prevent it. One was passed ; the other was never heard of in the year and nine months during which the patient survived.

[†] The following reasons have been given in explanation of this well-known fact—viz., the proneness of the cæcum to give way under the stress of distension and even when at some distance from the obstruction. Dr. Coupland and Mr. Morris (*Brit. Med. Journ.*, 1878) attribute it to the *cul-de-sac* nature of this part of the intestine ; its fixity ; dependent position ; its being the place where two currents meet—viz., from the ileum and, in case of regurgitation, from the colon ; and the pressure to which it is subjected between the iliacus and the abdominal muscles. Mr. Lockwood (*St. Barthol. Hosp. Reports*, vol. xix. p. 26) thinks that the explanation lies rather in the peculiarity of structure of the cæcum, as it

2. Extravasation of fæces and burrowing suppuration. This is especially liable to happen in very fat patients, in whom there is difficulty in getting the colon well up into the wound, especially if the bowel must be opened at once. As the fæces pump out under high pressure,* a free opening should in these cases be made in the bowel after this has been secured as carefully as possible.

3. Exhaustion. Especially if the operation has been deferred too long.

4. Vomiting. This has been noticed in a few cases to occur obstinately and fatally after colotomy. Mr. Couper (*Brit. Med. Journ.*, 1869, ii. 557) thinks that it is not an unfrequent cause of death, and suspects that traction on the bowel, its proximity to the stomach, and the fact that both receive nerves from the solar plexus, will account for this.

5. Septic cellulitis, erysipelas, &c.

6. Broncho-pneumonia; pleuritic effusion, especially if the wound has become septic in an exhausted patient.

INGUINAL, ILIAC, OR ANTERIOR COLOTOMY.

This, when performed on the left side for opening the sigmoid flexure, is known as Littré's operation.

Indications.

1. Iliac colotomy is usually performed on the left side in cases of malformation of the rectum, when this part of the intestine cannot be found by a dissection in the perineum. It has been disputed in these cases whether, after an unsuccesful exploration in the perineum, an inguinal or a lumbar colotomy should be performed. The great majority of surgeons have preferred the former operation, following here Mr. Curling (*Diseases of the Rectum*, p. 228). This surgeon pointed out that the lumbar operation was contra-indicated on the following grounds:—(*α*) the death-rate is relatively greater; (*β*) the kidney, varying in size at this time of life, may, when large, overlap the colon; (*γ*) the colon, instead of being distended with meconium, as might be expected, is sometimes contracted and very hard to find; (*δ*) in addition to the irregularities in the position of the colon

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contains a very large amount of lymphoid tissue, and as its walls are not strengthened equally with other parts of the large intestine by encircling bands.

* The danger of this may perhaps be diminished by the use of a trocar (p. 701).

which have already been mentioned, a meso-colon is frequently present.*

Mr. Morrant Baker,† as far as I know, is the only surgeon who has of late years advocated the lumbar operation in cases of imperforate rectum. His reasons appear to be that he thinks that Amussat's operation gives these cases "a good chance of an unwounded peritonæum," and that those who think Littré's operation the better one do so on insufficient grounds. It is noteworthy that Mr. Baker's case, though most successful and alive when last heard of, nearly three years after the operation, was not sent to him till the nineteenth day after birth, when "the abdomen was enormously distended, and the vomiting frequent, and the child much exhausted." No doubt if we could always thus defer operating in these cases, lumbar colotomy would be rendered much safer, but the peril of the children would be much increased. But from my experience at Guy's, and the Children's Hospital with which I am connected, the surgeon is called upon to interfere long before this. The question was raised by M. Huguier‡ whether, when the inguinal operation was going to be performed, the right loin should not be chosen, as he considered that on this side the surgeon was more certain to reach some part of the large intestine. M. Giraldès,§ on the other hand, has shown that all the inquiries undertaken to elucidate this subject tend to show clearly that the surgeon may rely on finding the sigmoid in the left groin. "Numerous anatomical investigations, together with the records of those of Curling and Bourcart, have shown me that in the great majority of cases in the fœtus and newly born child the sigmoid flexure is placed on the left, and not on the right. In 134 autopsies below the age of a fortnight I found the sigmoid flexure on the left side in 114; in 50 cases of Littré's operation which I have collected the operator always met with the sigmoid flexure on the left side; in 30 post-mortem examinations of infants operated on for imperforation the intestine was always found on the left; in 100 examinations of new-born children Curling found the sigmoid flexure on the left side 85 times; and Bourcart, who made prolonged researches in order to elucidate this question, found the sigmoid flexure in its normal position 117 times out of 150."

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* Mr. Curling (*loc. supra cit.*) gives the results of twenty dissections on the bodies of infants, both operations having been first performed. In eighteen out of the twenty, Littre's operation was found easy, whether the bowel was distended or no. In two, this operation failed, as the colon crossed the spine to run down, on the right side, into the pelvis. In eight out of the twenty subjects, lumbar colotomy was easily performed, without opening the peritonæum. In six, the operation was "more or less difficult," and, as Mr. Curling remarks, the difficulties would have been increased in the living. In six, lumbar colotomy was impossible owing to the distinctness and looseness of the meso-colon.

† *Clin. Soc. Trans.*, vol. xii. p. 240.

‡ *Bull. de l'Acad. de Méd.*, tom. xxiv. p. 445.

§ *Lec. Cliniq.*, p. 121. Quoted by Mr. Holmes (*Dis. of Children*, p. 179).

2. Of late years there has been an increasing tendency for iliac to replace lumbar colotomy in those cases of malignant disease which call for operative relief, and which are unsuited to excision of the rectum.

The advantages claimed for the iliac operation are chiefly—(i.) It is easier. Thus (α) the patient, being on his back, takes the anæsthetic better than when rolled on his side; (β) In a stout patient, especially, the soft parts are easier to divide, and the resulting wound less deep, and more readily dealt with than one in the loin; (γ) The bowel is more easily reached, and with less disturbance of deep-lying soft parts; (δ) There is no risk of opening small intestines, or of failing through abnormality of the colon. (ii.) The peritonæum being opened of set purpose, the surgeon can verify his diagnosis before opening the intestine. (iii.) The shallower wound makes it much easier to draw out the intestine, and make a satisfactory angle and spur, or to perform colectomy. (iv.) The position of the anus is more satisfactory to the patient.

If the above disadvantages are considered separately, I think that there is no doubt that the first, and this is the most important one, is correct. Where the colon is distended, the lumbar operation is a very easy one, but where the bowel is flaccid and lies deeply far away in a fat patient, the operation, in spite of the aids given at p. 686, is one of the most difficult in all surgery. I am speaking now from an experience of seventeen cases of my own and a large number which I have seen performed by my colleagues. Cases of such difficulty are not common, but, when they do occur, there is scarcely any operation more embarrassing. Iliac colotomy with the thinner soft parts, the deliberate opening of the peritonæum, and the more accessible colon, is no doubt a simple operation. The second advantage claimed, that an iliac colotomy enables the surgeon, by opening the peritonæal cavity, to verify his diagnosis, seems to me of less importance. In the great majority of cases the site of the disease which calls for colotomy is known, if not within finger reach. In the few cases of chronic obstruction which remain obscure, the difficulties of the case will best be met by performing right-sided lumbar colotomy or by exploring first in the linea alba. The third advantage is an important one in those cases where a deep wound loaded with fat makes it very difficult to bring up and anchor the colon satisfactorily. But I would not by this be considered to say that I deem essential for the formation of a spur those elaborate precautions and steps of no little severity which have been recommended with this view. I have alluded to this point later, p. 700. The fourth point, on which much stress has been laid, that an artificial anus in the loin is placed more satisfactorily for the patient's needs than one in the lumbar region, seems to me by no means established. With regard to necessary cleansing, adjustment of pad,* &c., a patient with an artificial anus in the lumbar region has no real difficulty with any of these things. And it is obvious that in some conditions of daily life a lumbar opening may be very superior to one in front. Thus I am now watching a case of lumbar colotomy which I performed five and a half years ago in a young married woman, who became the subject of rectal cancer at twenty.

The disadvantages of iliac colotomy next require attention.

1. There is the opening of the peritonæum. While I should readily allow that antiseptic details, faithfully followed, have gone far to remove the old dread of the peritonæum, there is no doubt that a general adoption of iliac colotomy, with its necessary opening of the peritonæum, in all cases and by all operators, will add to the risks of the operations, especially when the bowel is distended and fæcal extravasation most difficult to guard against. This point is again alluded to, p. 701. The condition of our patients before colotomy, too often low and poor in repair, and the readiness with which a little peritonitis, ultimately fatal, may be excited, must not be forgotten here.

2. A much larger amount of prolapsus follows this than the lumbar operation. Of this there can be no doubt whatever. It must be so, on anatomical grounds, viz., the far greater mobility of the sigmoid colon, the greater laxity of the soft parts in the groin, as compared with those in the loin, where we have the lumbar fascia, psoas, and kidney. These points, together with the fact that in walking, standing, and sitting the small intestines must necessarily tend to push upon and protrude an inguinal artificial anus, all explain why prolapsus after inguinal is so much more marked than after lumbar colotomy. This result, if the prolapsus

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* "A pad and bandage which is satisfactorily adjusted with the patient standing, will require readjustment with the patient sitting. . . . . I have been consulted by several subjects of iliac colotomy on this point, and found their grievance to be a real one" (Bryant, *Lancet*, 1881, vol. ii. p. 1215).

be a large one, causes great discomfort to the patient, the projecting, moist, readily bleeding mass in the groin interfering much with cleanliness and locomotion. While the precautions given later will serve to diminish the amount of prolapsus, this will always give more trouble here than in the lumbar region; a tendency to large prolapsus there is quite exceptional, with iliac colotomy it is the rule.

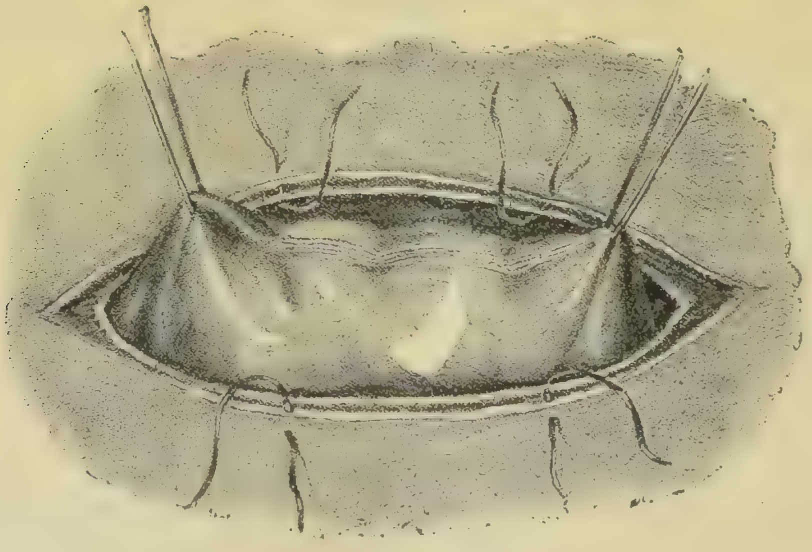
3. Another objection to iliac colotomy, and one which, I think, will be found a real one when more cases have been published, is that for disease high up in the rectum or of the sigmoid flexure, the opening will be placed too near the seat of mischief. Mr. H. Allingham does not attach much weight to these objections, as he has found from experiments on the dead body that, as a rule, only 4 inches intervene between the inguinal and lumbar operations, and as cancer of the sigmoid flexure is so rarely met with. With regard to the first of these points I would suggest that an artificial anus placed 4 inches away from the disease may be a very different thing as regards the comfort of the patient to one placed close to it. As to the rareness of the disease in the sigmoid flexure, the remark of Mr. Allingham does not coincide with the experience of Dr. Brinton and Dr. Fagge (p. 682).

From a comparison of the advantages and disadvantages of lumbar and inguinal colotomy, and from an experience of seventeen cases of the former and five of the latter, I am of opinion that the iliac operation is to be preferred when the bowel is likely to be empty, especially in a stout patient. Whenever the colon is distended, and in cases where it is needful to operate on the right side, lumbar colotomy, so well tried, and which has given such good results, should be resorted to.

Operation (Figs. 116 and 117).

The parts being duly cleansed and shaved when needful, an incision 2½ inches long is made 1½ inch above and parallel with the outer part of Poupart's ligament—the anterior superior spine. The layers of the abdominal wall (p. 611) having been divided, and all hæmorrhage arrested, the peritonæum is then raised, and slit up with scissors for about two-thirds of the wound already existing. The parietal peritonæum is now stitched to the cut skin on either side by a few points of chromic gut suture. This ensures peritonæal surfaces being in contact when the colon is brought up into the wound. While this suturing is going on, a small sponge should be placed in the wound. Either the sigmoid or the omentum or small intestine may be seen in the wound. If either of the two latter present, and the omentum may do so very persistently, they are returned, and the colon sought for with the finger. It is usually close at hand, and may be recognised by the scybala which it contains. In difficult cases the bowel will be found by searching in the iliac fossa, tracing up the rectum, or finding the descending colon over the kidney. The bowel being found, a loop of it is drawn up into the wound. In the next step the operator should carefully follow Mr. Cripps (*Brit. Med. Journ.*, 1889, vol. i. 771). To avoid the prolapse which is certain to occur if loose folds of the sigmoid remain immediately above the opening, this surgeon gently draws out as much loose bowel as will readily come, passing it in again at the lower angle as it is drawn out from above. In this way, after an amount varying from one to several inches have been passed through the fingers, no more will come. Two silk sutures are next passed at an interval of 2 inches through the upper longitudinal band—*i.e.*, the one next to the attachment of the mesentery. These sutures, which are left long, serve to steady the bowel while it is being sutured, and are useful as guides when the bowel is opened.* The colon is now fixed to the skin and parietal peritonæum on either side by fine carbolized silk sutures, six or eight being inserted on either side. Mr. Cripps advises that the sutures for the lower side should pass through the lower longitudinal band, since this is a strong portion of the gut. The upper longitudinal band, through which the guide-sutures have already been passed, occupies the middle of the wound. The bowel being next drawn down, the upper sutures are inserted

FIG. 116.



(Cripps.)

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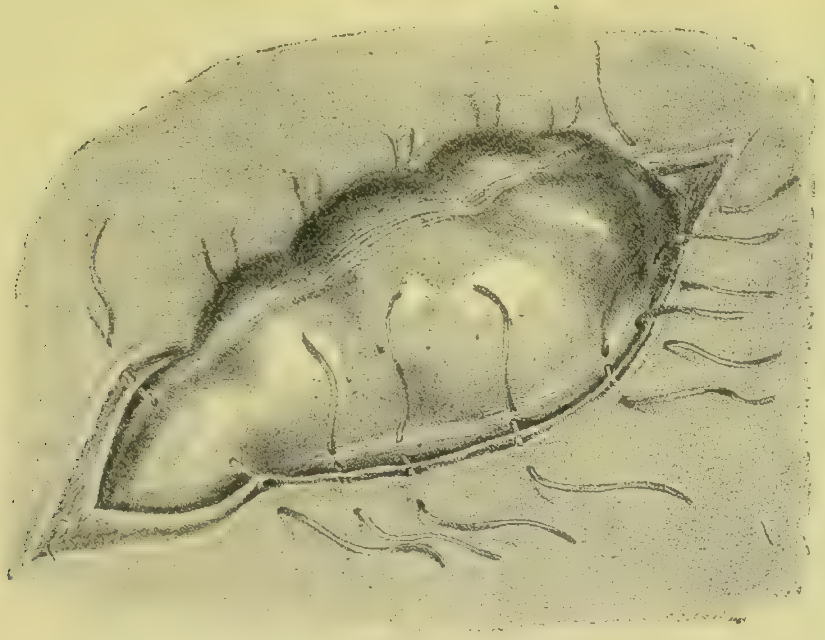
* As stated in the account of colotomy and gastrostomy by two stages, the exposed surface of the viscus is so altered with lymph, &c., that guiding stitches should always be made use of in adults.

close to the attachment of the mesentery. The sutures should be passed with fine curved needles, first about $\frac{1}{8}$ inch from the margin of the skin, and then through the peritonæal and partly through the muscular coat of the bowel, great care being taken not to perforate the mucous coat. After all the sutures have been parted, they are tied up, but not too tightly. Some sal alembroth gauze wrung out of carbolic oil is then applied over the bowel, and firm pressure maintained.[†] I have followed Mr. Cripp's mode of securing the bowel in five cases, and can strongly recommend it as both simple and safe. The bowel may be opened between the guide sutures, on the fifth day. No anæsthetic need be given; if the patient is nervous, a 20 per cent. solution of cocaine may be applied.

FIG. 117.[*]



(Cripps.)

All sutures should be removed by the tenth day, earlier if any redness is present.[‡] Mr. H. Allingham (*Brit. Med. Journ.* 1887, vol. ii. p. 875) advises a different method:—"When the gut is found and brought to the surface, I look for a piece with a sufficient mesentery; of course this can only be done if the disease is in the rectum or lower part of the sigmoid, for only the part of the sigmoid first picked up has quite sufficient mesentery. . . . A needle threaded with carbolized silk is passed through the mesentery close to the intestine on both sides, then through the abdominal walls on both sides nearer the lower than the upper angle of the wound, and these are tied up tight. If there is little or no meso-colon, I am obliged to pass the suture through the muscular and serous coats of the gut at its posterior part. Leaving a piece of loose gut outside the wound, I next sew it all round the skin, passing the thread only through the muscular and serous coats of the gut at its posterior part. . . . . To open the gut I use scissors, cutting the intestine from above downwards to the extent of about 1½ inch; through the incision can be seen two orifices separated by a well-formed spur, the upper opening being the larger, the lower the smaller." The lower of these is only required to clear out the rectum and to allow any retained fæces, &c., to come up. Mr. Allingham points out that it is important to fasten the gut well outside of the wound, for it is only by so doing that a good spur and its results are obtained.

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[*] This and the preceding figure have been kindly lent to me by Mr. Harrison Cripps.

[†] This is especially needed during the first few days. Mr. Cripps insists on the nurse sitting by the bedside to apply pressure if vomiting occurs.

[‡] Vomiting, and distension of the abdomen, are other indications for early opening the bowel.

As there is a large quantity of walls of gut on both sides of the incision, these are removed, when firmly adherent, the intestine being cut away till its edge is on a level with the skin.* This step is stated to be attended with but trifling hæmorrhage and to be absolutely painless. Quantities varying from 3½ to 6 oz. in weight of intestine have been removed in this way.

I cannot but consider this method needlessly severe. The kind of patients with whom the surgeon is now usually dealing must never be lost sight of. They are too often the subjects of a mortal disease with no long tenure of life before them, pulled down in strength and feeble in repair. Mr. Allingham lays great stress on his method of thus pulling out the intestine, as alone certain to provide the spur which he considers so essential, while he allows that this pulling out of intestine will be followed by prolapse. This, again, necessitates later on the cutting away of these large amounts of bowel materially thereby, as he admits, increasing the seriousness of the operation.

In the five cases in which I adopted Mr. Cripps's far simpler and milder method, simply pulling out as much loose sigmoid as will easily come, returning it at the lower angle as it is drawn out from above, and fixing the part which is found to be tight, in the wound, fæces ceased entirely to come per anum after the first three weeks, occasional blood and slime from the rectal growth alone escaping this way. There has been more prolapsus after these operations than with lumbar colotomy, but, as stated above (p. 696), this must be the case with the widely different anatomical conditions of the parts.

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* Though the bowel shrinks, it does not do so sufficiently, hence it is advisable to remove it.

Where the bowel is distended and requires immediate opening every care must be taken to prevent any fæcal fluid leaking into the peritonæal cavity. Additional pains having been taken to suture the bowel accurately to the edges of the wound, relief may be given to the tension by incising the bowel and washing away the contents as they escape with a stream of boiled water, which is kept constantly pouring over the wound, until the distended bowel has completely relieved itself. (Cripps). Mr. Barker (*Man. of Surg. Oper.* p. 309) advises that in these cases the distended intestine should be opened with a fine trocar. On withdrawing the cannula the puncture is at once closed by mucous membrane. In one case Mr. Barker drew off the fluid through a temporary puncture for several days before a permanent opening was established. The patient made an excellent recovery.

If there has been prolonged distension the first method will be the wisest, as it will give most rapid relief to the intestine. The risk of over-distension, perforation and peritonitis in these cases is well known. In either case, whether the bowel is opened by incision or puncture, it should be well held up at the time by the guide-stitches.

If the artificial anus be found to be too small, it must be dilated with laminaria tents and the patient's finger. Mr. Cripps has introduced a spring dilator which is self-retaining and which can be worn for four or five hours daily. He points out that contraction is most likely to occur where the wound has healed by granulations—*e.g.*, in cases where the early opening of the bowel has necessitated abandonment of the antiseptic treatment.

Mr. Cripps considers that nothing in the way of a plug or truss answers so well as a dressing of lint smeared with some simple ointment covered with a large flat pad of cotton wool, the whole being kept in position by a wide flannel bandage, a perinæal strap being used if needful.

CHAPTER IV.

OPERATIONS OF THE KIDNEY AND URETER.

NEPHROTOMY—NEPHRO-LITHOTOMY—CALCULUS IN URETER—NEPHRECTOMY—NEPHRORRAPHY.

NEPHROTOMY.

As this operation is performed by the same steps which form the preliminaries of more important operations,* and as the conditions which call for it are dealt with a little later, it will be only briefly considered here.

Indications.—Partly as an exploratory and partly as a curative step. (1) In hydro-nephrosis resisting tapping (p. 734). (2) In pyo-nephrosis, the pelvis and ureter being carefully explored. (3) In tubercular disease that the kidney may be explored and drained in view of an early nephrectomy (p. 733). (4) In suppression of urine, probably calculous.

Operation.—The kidney, being exposed by the incision fully given below, is punctured with a fine trocar, and the puncture converted into a small incision, which is plugged with the finger, and dilated with this and dressing-forceps. An assistant steadies the organ by firm pressure from the front. When the fluid has been evacuated, very free drainage must be provided, by the largest sized drainage-tube, any cyst opened being stitched to the margins of the wound, and the same precaution being adopted in the case of a suppurating kidney which drops down much, thus risking septic leakage into the cut planes of cellular tissue.

Hæmorrhage is not unfrequently met with in the form of troublesome oozing from a suppurating kidney. In a delicate tubercular patient this must be promptly arrested by plugging the wound in the kidney itself by strips of aseptic gauze carefully packed round the drainage-tube and bandaging with firm, even pressure. I have often in these cases had a little ether given when the strips are removed (p. 716).

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* See the full account of nephro-lithotomy, p. 703.

NEPHRO-LITHOTOMY.

Indications.—Before a nephro-lithotomy, safe as it usually is, is decided upon, the following points should be considered :—

A. That failures to find a stone are by no means infrequent.—Nephro-lithotomy is one of those advances in modern surgery in which the operation has outstripped the diagnosis. What with the pitch of excellence to which our anæsthetics, instruments, and the aseptic precautions, both during and after the operation, have been brought, what with the comparative simplicity and uncomplicated surroundings of the organ which we attack, the operation of nephro-lithotomy has been rapidly perfected, while the diagnosis of stone in the kidney often remains uncertain to the last. Mr. H. Morris, in his address before the Medical Society in 1885, said he knew of fifteen cases more or less typically indicative of renal calculus, in which an exploratory operation failed to find a stone. There is strong reason to believe that while every successful case of nephro-lithotomy is published, a large number of unsuccessful explorations are never heard of. To mention my own experience, while I have twelve times removed calculi by nephro-lithotomy, I have on five occasions explored kidneys for stone, both by multiple puncture and incision, without result. These five cases must be alluded to : (1) A case of lithiasis in a hypochondriac, who greatly exaggerated his symptoms, and having heard of nephro-lithotomy, asked for the operation. Dr. Pye-Smith, whose patient he was originally, and I were very doubtful about the existence of a calculus. After the operation the pain was lost with suspicious rapidity, and the patient remained well when last seen, seven months later. As I did not explore with a sound into the pelvis and calyces in this case (p. 716), it is possible that I overlooked a small stone, which subsequently became fixed and painless. (2) A case of painful movable kidney, in which the pain was referred to an attack of gonorrhœa, which perhaps set up slight pyelitis. (3) Malignant disease involving the last dorsal nerve, secondary to carcinoma of the bladder. This case shows how closely the presence of renal calculus may be simulated, and how misleading evidence may be. Five years ago a patient, aged forty-four, came under my care with hæmaturia, wearing pain, tenderness in the right loin and thigh, and oxaluria. His childhood had been passed in Norfolk, and, as a lad, he had been cut by Mr. Birkett for stone in the bladder. I sounded him twice, and finding no stone, I swept the sound in contact with the bladder in different directions, in the hope of detaching fragments of growth, if one were present. No relief being given by drugs. I explored the right kidney, and could find nothing abnormal. Four days after the operation, while all seemed to be doing well, the patient died very suddenly. The *post-mortem* examination showed (*a*) a primary carcinomatous growth in the bladder* of a somewhat unusual kind; it involved the apex, as a flocculent, superficially-ulcerated area; (*b*) a ring of secondary deposit surrounding the *right* last dorsal nerve, just at its exit from the spine; (*c*) a mass of enlarged glands around the inferior cava, and at one spot sprouting into it; (*d*) the *left*† kidney contained a large branching calculus. (4) A case of pain and hæmaturia with granular kidney. The patient here, aged sixty-one, had constant hæmaturia and left lumbar pain, as the specific gravity of the urine did not exceed 1012, I contented myself with exploring the kidney with a needle, after it had been exposed. Bronchitis, running into broncho-pneumonia, largely due to foggy days, carried off this patient on the fourth day. The kidneys were granular, the left especially so. I should have acted much more wisely if I had watched this patient longer, but the hæmaturia had baffled much painstaking on the part of the medical man who sent him to me, and I attached far too much importance to uric-acid crystals in the urine. This occurred to me before the papers of Dr. West and Mr. Bowlby, to which reference is made later, had appeared. (5) This was, I believe, in the light of a larger experience, very early tubercular disease.

B. Symptoms and Conditions justifying Nephro-lithotomy.—1. *Continued Hæmaturia or Passage of Blood and Pus.*—I may at once be criticised for putting this first; and, indeed, it is somewhat difficult to decide which symptom of renal calculus is clinically the most important. On the whole, I am inclined to agree with an old friend, G. A. Wright, of Manchester (*Med. Chron.*

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* The hæmaturia, frequent micturition, and acid urine led me to discuss the probability of growth in the bladder. The urine was repeatedly examined for cells, and the bladder was sounded under chloroform in the hope of detaching some growth. This was, however, nullified by the position which the primary growth occupied, and by its small size.

† No history of pain had been given here, the patient's attention having been drawn to the *right* side, where so terrible a cause of suffering existed. As bearing on the occasional latency of renal calculus, I would refer my readers to p. 722.

‡ Being convinced of the frequency of errors of diagnosis in renal calculus, I have dealt with these fully. I may also refer my readers to my paper, *Brit. Med. Journ.*, 1890, vol. i. p. 117.

March, 1887, p. 463), who considers "renal hæmaturia as the only single symptom of anything like cardinal importance," if of more than a year's standing, without evidence of nephritis, and if without a co-existing renal swelling.

A few words as to the character of the hæmaturia of renal calculus and the fallacies which must be borne in mind. It is a hæmaturia of long standing, often repeated, frequently increased by exercise, rarely profuse, and never producing anæmia, as in growth of the kidney. Always intimately mixed with the urine, its tint varies from a bright or a deep red (which I think are rare) to a smoky or porter-like colour.

Fallacies: (*a*) Hæmaturia may be absent from first to last. This, an undoubted fact, is one very difficult of explanation. It was the case with the smaller calculus (Fig. 118). And this is the more extraordinary, as the stone is covered with minute crystalline spicules, a condition which would have appeared certain to lead to oozing from the inflamed mucous membrane of the pelvis in which this stone lay. The only explanation that I can give is that at the operation I found the abdominal muscles extremely rigid; even when the patient was fully anæsthetised, they gave the impression to the scalpel of cutting through tissues frozen by ether. Now, if it is fair to suppose that on the other side of the kidney the quadratus and psoas were as firmly contracted, the kidney and the stone in its pelvis may have been so firmly held that no irritation by the calculus could take place, and thus no hæmaturia. (*b*) Another fallacy is that the hæmaturia of calculus may be only temporary, present for a while and then ceasing altogether. This occurs, though rarely, when a small renal calculus becomes encysted. (*c*) The value of hæmaturia, though only occasional, is shown by a case of Dr. Owen Rees, to which Mr. Morris has drawn attention. It was that of a young lady with lumbar pains and frequent micturition, which were both put down to the hysteria that was markedly present. After a while, hæmaturia was found to be present on several occasions, and eventually, after death, a mulberry calculus was found in one kidney. Other fallacies are presented by the host of kidney conditions which may give rise to hæmaturia—namely, (1) the passage of uric acid crystals; (2) tubercular kidney; (3) granular kidney; (4) growths; (5) increased intra-renal pressure, &c. To these I shall refer later.

2. *Pain and Tenderness, Lumbar and elsewhere.*—(*a*) Fixed lumbar pain. Characters: Usually dull, gnawing, pricking or aching, increased usually by exercise, twisting from side to side,

or flexing the body.* Sometimes it is relieved by pressure of the hand, leading to thickening and vascularity of the parts when they are incised at the operation. (*b*) Radiating pain, for example, in the testis,† region of the small sciatic nerve, calf, foot, or in the intestine simulating colic. It is easy to see how readily the pain of a renal calculus, if limited to distant parts, and if occurring without hæmaturia, may mislead. Another point with regard to the pain of renal calculus is the frequency of nocturnal exacerbations. The explanation of this is doubtful, whether, as Mr. Morris has suggested, from the passage of flatus in the colon, at this time over a stone in the pelvis, or, as I venture to think more probable, as accounting for stone both in the pelvis and in one of the calyces, to the concentration of the urine, and consequent deposit of crystals, which takes place at night, is unsettled. The fact, however, is undoubted. In the case of a patient, aged fifty-eight, who had suffered from symptoms of renal calculus for thirty years, and from whose left kidney I removed the huge calculus (Fig. 118), the pain at night was often so severe as to drive him from his bed into his garden or the streets of the town in which he lived.

With regard to *tenderness*, Mr. Jordan Lloyd (*Pract*., vol. xxxix. p. 178), in a paper to which I shall have again to refer, writes thus: "I attach great importance to the evidence to be obtained by immediate percussion over the suspected organ, a method of investigation which has not received that amount of attention to which it is entitled. It is best practised from the loin, just beneath the space between the tips of the last two ribs, and should be made in a direction upwards, forwards, and slightly inwards. It is best for the patient to stand upright before you. The blow should be sharp and decisive, and of force sufficient to affect a structure situated several inches below the surface. It may also be practised from the front, at a point midway between the umbilicus and ninth rib. When a calculus is present, the patient will complain of sharp, stabbing pain at the moment of percussion. Other conditions doubtless give rise to percussion pain, but not of the characteristic stabbing of calculus."

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* As in going upstairs, probably from the pressure on the kidney by the contracting psoas. But the relation of the pain to movement, and the kind of movement which most induces pain, vary greatly. Thus Mr. Butlin's patient is said to have suffered greatest pain when driving, least when riding. Prolonged walking seems the most frequent cause.

† In a case of Mr. Butlin's (*Clin. Soc. Trans.*, vol. xv. p. 113) the patient sought relief from severe neuralgia of the right testis, which was generally retracted and extremely tender. Later on it was noticed that these neuralgic attacks were associated with some lumbar pain and tenderness. Complete recovery followed after the removal of a small, prickly, calcium-oxalate calculus from the pelvis of the right kidney.

I have tried the percussion test of Mr. Lloyd in the eight cases which have come under my hands for nephro-lithotomy since his paper was published. In three the tenderness was increased, but in one only was there any "characteristic stabbing." In this, where a small and very spiculated oxalate of lime calculus occupied the top of the left ureter, the patient at once said, "You stab me there." This patient, No. 5 in the table, p. 732, was thin and spare.

3. *Points in the Previous History.*—Space will only allow of my noticing a few of those given above, namely, lithiasis and oxaluria, history of a previous stone, history of previous colic.

The history of long-standing lithiasis and oxaluria is of obvious importance, from the fact that the habitual passage of crystals or gravel and the formation of a calculus lie not far apart. But there is another point which has not, I think, received sufficient attention, and that is, that in patients who have habitually, for many years, passed uric acid and oxalate of lime, there is a most serious risk that the minute anatomy of their kidneys will have become seriously damaged by the constant presence of the above crystals. We should all be agreed as to the damaging effect of multiple calculi on the secreting tissue of the kidney. I would suggest that in the future the results on the kidney of the daily passage of crystals of uric acid and lime oxalate must receive sufficient attention before patients at all advanced in life are submitted to nephro-lithotomy. Furthermore, it is obvious that long-continued lithiasis and oxaluria will very likely have led to the formation of bilateral stones.

Under the heading of Renal Colic, I would point out that the vomiting and nausea which are thought to be characteristic of the agony of a descending calculus may also be caused by a stone which is distending the renal pelvis, and which has not yet begun to make its way down.

4. *Frequency of Micturition.*—The coexistence of irritability of the bladder with renal calculus is well known, and may be explained either by nerve disturbance, or by the blood and pus, or the over-acid urine which often accompanies stone in the kidney. I had hoped that this symptom might prove to be useful in the diagnosis of the site of the stone.

We all know that it is to the pelvis and hilum that the nerves are most freely distributed, and that it is this part of the kidney which is most closely associated with the bladder. For some time

I hoped it might prove that if a patient has renal calculus and no bladder irritability, the absence of this symptom would point to the stone being in one of the calyces and not in the pelvis of the kidney. The importance of this distinction, if it existed, will be recognised by any one who has performed nephro-lithotomy. A question always arises before the operation, namely, Where shall I find the stone, in the kidney itself or in its pelvis? A stone in the pelvis is, as a rule, easily found and removed. A stone in the tissue of the kidney, even if near the surface, is much more difficult to find, while one embedded in a deeply lying calyx may be overlooked, as in Mr. Morris's well known case (*Med. Chir. Trans.*, vol. lxviii.). I fear, however, this symptom is not reliable. Irritability of the bladder may be absent with a stone in the pelvis of the kidney, and may be present with a calculus in one of the calyces.

Another point with regard to bladder irritability is that it may be of value in making that most difficult diagnosis between calculous and tubercular kidney. Thus, if a patient with hæmaturia, lumbar pain, &c., has irritability of the bladder which is not relieved by rest in bed, which continues by night as well as by day, it is probable that this is due not to trouble in the kidney alone, but to coexisting ulceration of the bladder, probably confirmed by examination of the prostate and vesiculæ seminales in the male, and by digital exploration of the bladder in the female.

5. *Absence of any Condition in the rest of the Genito-urinary Tract which will explain the Symptoms* (Morris).—"Various diseases of the prostate—tubercle, abscess, and stone, certainly—may give rise to symptoms which simulate renal calculus. It has happened to me twice to explore the kidney for stone, with negative results, and the subsequent course of the case has shown that the symptoms were caused by tubercular disease of the prostate. In another case, subsequently to the exploration of the kidney, I had to open an abscess of the prostate; and in a fourth case, where nothing was found at the exploration of the kidney, a prostatic calculus was discovered after death" (Morris, *Brit. Med. Journ.*, 1889, vol. ii. p. 1082).

6. *Failure of Previous Treatment to give Relief.*—I can only touch on one point here—*i.e.*, the question of the advisability of trying to exert any solvent action on a calculus in the kidney. Whilst, for myself, I attach the greatest importance to the use of large quantities of water, it is rather because this, by washing out the kidneys, removes collections of crystals, and gets the patient

into a better state for operation, than because I believe in its possessing any actively solvent action upon the calculus. I do not forget that Sir W. Roberts has proved by experiments on calculi, both those without the body and those in the bladder, that urine rendered alkaline by fixed alkali has a distinctly solvent action. Dr. Ralfe has reported (*Path. Soc. Trans.*, vol. xxxiii. p. 206) a case of a patient, aged thirty-seven, who, after suffering from uric acid gravel for some years, had a violent attack of renal colic, with profuse hæmaturia, no calculus or gravel being discharged. Alkaline treatment was at once resorted to, and for a time afforded relief, but the patient could not be persuaded to continue it systematically. He was then ordered to drink copiously of soft water—filtered rain water. Two years later he began to pass grit and scales of calculous matter with his urine; and shortly afterwards, after a severe attack of colic, he passed the shell of what had evidently been a solid calculus.*

But it must be remembered that, as my late colleague Dr. Hilton Fagge pointed out (*Medicine*, vol. ii. pp. 373, 383), such solvent treatment is only worth trying in the case of uric acid calculi. He at the same time showed that the greater relative frequency of lime oxalate calculi over those of uric acid, especially in patients after early adult life, is much more marked than is generally believed.

C. Chief Conditions simulating Renal Calculus.—This point has not received sufficient attention.

1. *Lithiasis.*—I have already alluded to this condition, as one which simulates renal calculus by the hæmaturia which crystals of uric acid may cause. Lumbar and testicular pains are also points which mere lithiasis shares with renal calculus. The diagnosis will not be difficult by watching the result of treatment which only gives relief in the one, but clears up the other. Exercise, again, is a test. A patient with renal calculus, who declines or is

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* Dr. Ralfe (*Diseases of the Kidneys*, p. 523) points out that the solvent action of distilled water is due to several influences. In the first place, by causing a low specific gravity of the urine, it induces disintegration, since Rainey has shown experimentally that bodies placed in solutions of different density to those in which they were formed undergo molecular disintegration. Again, chemical analysis has shown that those calculi that undergo spontaneous disintegration are always poor in inorganic constituents, the use of soft water diminishes the supply of these, even if it does not actually act as a solvent on those forming the outer crust of the calculus, and so increases the tendency to disintegration. Lastly, soft water probably diminishes the catarrh of the urinary passages, and by diminishing the swelling of the mucous membrane allows a small stone to pass which was before obstructed.

unsuited for operative treatment, is often much crippled in carrying out palliative treatment, and made worse by the exercise which is otherwise so essential to him.

2. *Tubercular Kidney.*—Lumbar pain and tenderness, frequent micturition, hæmaturia, are all common to tubercular kidney and renal calculus. The chief aids in the diagnosis appear to me to be: (*a*) the pyuria; (*b*) careful examination of the urine; (*c*) early pyrexia; (*d*) early exploration of the kidney.

(*a*) Pyuria.—This is usually present early in the case with a proportionate amount of albumen, without much hæmaturia, the blood often occurring only as a thin layer over the pus at the bottom of the urine glass, or as small, thready clots. With all the pus the urine is strongly acid at first, then more feebly so, but often remains slightly acid to the last. (*b*) Careful examinations of the urine.—The sediment contains caseous matter, and sometimes *debris* of connective tissue can be made out, a point of much importance. Finally, there is the bacillus tuberculosis. While I am well aware of the frequent want of success in demonstrating the presence of the bacillus in urine as in bone, I may add that it was found in three out of the eight cases in which I have been asked to explore tubercular kidney.* (*c*) Pyrexia. —I do not here speak of the hectic which accompanies the advanced stage, but the pyrexia which may be an important factor in the diagnosis much earlier in the case. Often intermittent at first, and liable to be overlooked in the anorexia, nausea, and debility which accompany it, later on, and too late, it becomes only too evident and confirmed. (*d*) Early exploration of the kidney.—This matter is referred to later, p. 733.

3. *Slight Pyelitis, not Tubercular.*—This condition may by hæmaturia, pus in the urine, lumbar and testicular pain, simulate renal calculus closely. It may follow a gonorrhœa, perhaps a

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* I may point out here that bacteriology will help the surgeon in difficult cases. My colleague, Dr. Washbourne, has thus cleared up two obscure cases for me this year. One, a delicate woman of thirty-two, with a tubercular history, was sent to me by Dr. Forty, of Wotton, in Gloucestershire, with obstinate cystitis and irritable bladder. The endoscope and digital exploration showed swollen and hyper-vascular mucous membrane, but detected no ulceration. Wiping over the mucous membrane with solution of silver nitrate (gr. 40—℥j) was followed by very great relief lasting over two months on two occasions. At my request Dr. Washbourne injected some of the pus containing urine (in which no bacilli could be found) under the skin of a guinea-pig. No result apparently followed, but when the animal had been killed, *one* of the nearest chain of glands was enlarged, and caseating. A few undoubted bacilli tuberculosis were found in it. This and the other case will be found in the *Guy's Hosp. Rep.* 1890.

previous stone, or occur in women after pregnancy; probably, as Dr. M. Duncan thinks, from some parametritis extending up the psoas to the peri-renal fat and kidney.

4. *Movable Kidney*, especially if associated with neuralgia, pyelitis, or if occurring with some of the reflex causes of nephralgia to be mentioned below.

5. *Aching Kidney.*—Under this title Dr. M. Duncan has described a condition, especially common in women, which may simulate renal calculus. Its chief features are a heavy wearying pain deep in the side, usually accompanied by tenderness, often great; the pain may run in the course of the great sciatic or anterior crural, and is frequently accompanied by irritability of the bladder, and by pain in the course of the ureter. The disease is liable to be aggravated by exercise. The chief points in the diagnosis of this condition are, Dr. Duncan points out, the absence of blood and pus, the fact that the "aching" often occurs only at the menstrual periods and is always worse then, from the intimate connection between the kidneys and the generative organs, not only developmental but pathological.

6. *Nephralgias due to Disease in Parts adjacent to the Kidney.*—Dr. Ralfe (*Brit. Med. Journ.*, 1888, vol. i. p. 183) gives some of these; one, he thinks, is duodenal ulcer. Thus, a patient had many symptoms of renal colic, and three attacks of paroxysmal pain accompanied by vomiting, great tenderness in the right renal region, urine loaded with uric acid, but no pus or blood. The patient, who was losing flesh, recovered with treatment directed to duodenal ulcer. The same writer gives another interesting instance of intestinal irritation simulating nephralgia by causing severe pain in the right hypochondriac region. The patient was treated for biliary colic, and a few days later, instead of a gall stone, a large round worm was passed, giving relief to the pain.

7. *Gall Stones retained in the Gall Bladder* may be taken for right renal calculus. Dr. Murchison pointed out long ago that they not infrequently coexist. My old friend, G. A. Wright, of Manchester, has recorded (*Lancet*, 1885, vol. i. p. 563) a case in which the right kidney was explored for a calculus believed to be in the ureter. On exploring this tube a hard spot was felt near the brim of the pelvis, and taken for a stone in the ureter. A calculus the size of a pigeon's egg was removed and found to be a gall stone. Acute peritonitis carried off the patient, and a stone was found to exist in the pelvis of the right kidney, with its apex in the ureter.

While on this subject of nephralgias due to conditions of viscera near the kidney, I may refer to some remarks of Mr. Godlee (*Pract.*, vol. xxxix. p. 246) in which he insists that repeated attacks of intestinal colic, especially if accompanied by nausea, may be the only symptoms of the presence of either a renal or biliary calculus, and that this fact should lead the practitioner to investigate the state of the kidney and urine, bearing in mind the possibility of the symptoms being due to renal or biliary calculi.

8. *Spinal Disease.*—The great difficulty which may arise in diagnosing between certain cases of spinal caries and renal calculus is not yet sufficiently recognized. A writer, already quoted, from (G. A. Wright, *Med. Chron.*, No. vi. p. 642), thus alludes to this matter: "Where a local patch of caries of a vertebral body exists, and especially where deep suppuration occurs and presses upon the kidney, as in a case of my own and one or two others which I have seen, nearly all the symptoms of a calculus have been present. In my own case, without any deformity or tenderness of the spine, there was unilateral rigidity, testicular pain, intermission of symptoms, increased frequency of micturition, nausea during attacks, and oxaluria with local pain and tenderness. Subsequently an abscess developed, and on exploration a small patch of caries was found, and the kidney was felt exposed in the anterior wall of the abscess cavity. Probably, as in floating kidney, obstruction of the vessels and ureter may arise and cause symptoms, so that pressure of the spinal abscess may disturb the kidney, and quite possibly give rise to hæmaturia."

9. *Interstitial Shrinking Nephritis.*—This condition may simulate renal calculus both by hæmaturia and pain. Dr. S. West (*Lancet*, 1885, vol. ii. p. 104) drew attention to the hæmaturia which may accompany granular kidney, and published three cases, aged twenty-one, nineteen, and twenty-four; in the first the hæmorrhage was profuse. Mr. Bowlby (*Clin. Soc. Trans.*, vol. xx. p. 14) also published three cases, aged seventy-three, forty-nine, and sixty-four; two of these died, and the kidneys were found markedly granular. He points out the following as distinguishing this condition from renal calculus:—The specific gravity of the urine, after the blood has cleared up, only 1008 to 1015; tortuous arteries, cardiac hypertrophy, and high arterial tension; blurred, ill-defined discs, some retinitis and effusion amongst the blood-vessels. The paper concludes with the following warning: "Unless it be recognized that blood may emanate from a kidney which is simply granular, operations may be undertaken for the removal of renal calculus."

I have only space just to mention two other conditions which may simulate renal calculus; they are:

10. *Growth of the Kidney in its Early State, and Malignant Disease, involving the last Dorsal Nerve.*—I have already, at p. 703, quoted a case belonging to the second group here given, which well shows how closely the presence of renal calculus may be simulated, and how misleading evidence may be.

Operation.—The patient being in much the same position as that for lumbar colotomy, on the sound side, with a firm pillow under the opposite flank, the surgeon defines, carefully, the lower border and length of the last rib. That this is not an unimportant detail in renal operations is proved by the fact that Prof. Dumreicher,* of Vienna, accidentally opened the pleural cavity during an attempt to remove a pyo-nephrotic, calculous kidney. *Post mortem* it was found that the last rib was rudimentary, that the pleura projected a good deal below the lower edge of the eleventh rib, and that thus, when the incision was carried upwards, the accident had become unavoidable. Dr. Lange, of New York, has called attention to the investigations of Dr. Holl,† of Vienna, on the frequency of rudimentary development of the last rib, and the importance, therefore, of counting the ribs before intended operations on the kidney. Dr. Lange‡ himself shows that, in some cases, which are, however, exceptional, even normal development of the twelfth rib may demand extreme caution, as the pleura may project considerably below it.§

The surgeon, having defined the length and position of the lowest rib, makes an incision,‖ 4 inches long, ½ inch below it, and beginning about 2½ inches from the spine. The skin and fasciæ being divided, the muscles—viz., anterior fibres of the latissimus dorsi, the external and internal oblique—are cut through, either on a director, or simply by light sweeps of the knife. As soon as the yellowish-white lumbar fascia is reached, any bleeding vessels which have been temporarily secured with Spencer Wells' forceps are tied or twisted. If the last dorsal nerve cross the incision, it, together with its accompanying vessels, should be drawn aside and left untouched if possible. The lumbar fascia is next slit up on a director. The peri-renal fat which next bulges into the wound is then torn through with two pairs of dissecting-forceps. With two large retractors opening up the wound, the surgeon continues to tear through the above fat* till he can see or easily feel the posterior surface of the kidney. During this first stage of the operation the surgeon will find sometimes that the muscles are much thickened by reflex irritation from the presence of the stone, and, if the stone has been combined with suppuration and peri-renal inflammation, the tissues will be more or less densely blended and matted together.

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* Quoted by Dr. Lange, *loc. supra cit.*

† Dr. Holl found that in quite a considerable percentage the last rib is so abnormally short that it does not reach as far as the outer border of the sacro-lumbalis, or so rudimentary that in some cases it more resembles a transverse process; that in these cases the lower edge of the pleura passes from the lower boundary of the last dorsal vertebra, almost horizontally, towards the lower edge of the eleventh rib.

‡ *Annals of Surgery*, vol. ii. October 1885, p. 286.

§ In other cases the reverse condition may be present; though the last rib be rudimentary, the pleura may pass from the lower edge of the eleventh dorsal vertebra horizontally towards the eleventh rib, and thus be altogether out of danger.

‖ The parts being previously cleansed with mercury-perchloride solution (1 in 1000).

An assistant now makes powerful pressure on the opposite side of the abdomen, so as to keep the kidney up into the wound, this being widely opened by full-sized retractors, aided, if needful, by an assistant pulling up the lower ribs with a hand previously made aseptic. Thus the surgeon is enabled to examine the organ, which is done systematically; the finger is first directed to the pelvis, then the posterior surface; next, by passing the finger round the outer border, the anterior surface, which, as Mr. Howse has pointed out,† can be done effectually by pressing the kidney back against the firm unyielding psoas. The sensation given by a stone has been compared to that of an uncut end of a pencil (Morris), or the last joint of a finger (Howse).

If the above means fail, the incision must be made sufficiently free, especially in a fat patient, and a deep loin, to expose the kidney more thoroughly. Additional room may be gained by converting the usual lumbar incision into a T-shaped one, or by making use of König's incision, in which the muscles are cut through as far as the rectus, and the peritonæum pushed forwards. A small stone in a kidney will always be liable to be overlooked, but a surgeon does not give his patient or himself a fair chance who is content with exposing the kidney through a limited incision, and then trusting to punctures with a needle.

If the stone cannot be felt either in the pelvis or after palpation of the posterior and anterior surfaces of the kidney, this should be drawn up and out of the wound as far as possible, and again examined, a careful watch being kept upon the pulse.

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* If this fat is very abundant, some of it should be ligatured with chromic gut and removed; poorly vitalized, it is prone to suppurate tediously and to delay healing.

† *Clin. Soc. Trans.*, vol. xvi. p. 93.

If no stone can be felt by the exploring finger, a needle firmly mounted in a handle, or in torsion-forceps, should be thrust into the different parts of the organ, exploring it by successive punctures made at short distances; twelve or more such punctures may be made.

All the above, including palpation of the kidney between the finger and thumb, failing, the kidney itself must be incised and explored with a sound. The kidney may be opened either near the pelvis* or at its outer border; in either case it is best to incise boldly with a scalpel and then to dilate with a finger. The opening having been dilated sufficiently, if the finger detects nothing, a child's bladder sound is introduced, and an attempt made to explore the calyces systematically. In the case of a small stone lying deeply in the substance, the upper part of the kidney, perhaps well up under the ribs—and it is these stones which are, I think, most often missed—the click which a sound gives is very faint and distant. It is to Mr. Jordan Lloyd (*Pract.*, vol. xxxix. p. 173) that we owe directions for systematically exploring the kidney, and it is to his method that I owe my finding the stone in case No. 8 of the subjoined table, where the calculus lay, not in the pelvis, but deeply embedded in an upper calyx. The following are Mr. Lloyd's words:

"When the kidney is exposed through a lumbar wound I puncture its lower end with a long-bladed tenotome in a direction upwards and inwards, making for the lowest of the calyces.

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* In the following case, under the care of Mr. T. Jones, of Manchester (*Med. Chron.*, June 1887, p. 212), this step of opening the pelvis alone sufficed to find the stone, after systematic exploration of the kidney had failed:—"The forefinger was passed to the anterior surface, and the organ grasped between the finger and the thumb; nothing, however, could be felt. The kidney was then carefully explored by systematic puncture with a long needle, also passed towards the pelvis, but no calculus could be found. An incision, sufficiently large to admit the tip of the index-finger, was then made through the kidney substance into the pelvis by means of a fine bistoury. On introducing the forefinger, a small stone was discovered firmly lodged in one of the superior calyces. Small, straight lithotomy forceps were introduced, and the stone thus removed." Very free hæmorrhage attended the above incision, but it yielded to pressure made with carbolized sponges and kept up for five minutes. The patient made a good recovery. The calculus, consisting of lime oxalate, weighed twenty grains. This plan of opening the pelvis might be thought to cause a risk of leaving a urinary fistula, but the numerous cases in which calculi have been removed from the renal pelvis with entire success do not support this view.

If the surgeon is observant and his knife is keen he will readily appreciate the moment when a cavity is struck by the altered resistance offered to the puncturing instrument. . . . . It is important, because a tenotome may be pushed up to its handle in a normal kidney without tapping its interior cavity, having travelled *along* the kidney substance rather than *through* it. Into this opening I pass a child's bladder sound, and systematically explore the whole of the pelvis." It is advised that the blade should be not more than one-third of an inch in length, a stem of about 7 inches, and the size of a No. 3 English catheter. It should be passed at once to the top of the kidney cavity, a distance of nearly 4 inches, and the exploration should be carried out systematically from above downwards, the point being rotated in all directions, so as to investigate the calyces as the instrument is withdrawn. Hæmorrhage from an incision into the kidney is usually free, but is arrested by the exploring finger or by holding the lips of the wound around the sound. Later on it is stopped securely by firm, careful plugging with strips of sal alembroth gauze. On the five occasions on which I have used this plan I have removed the strips the next day with the aid of a few minutes' anæsthetic, gas sufficing for this. It is said that this plugging may cause vomiting. This did not occur in any of my cases. It ceases on the removal of the plugs. Care must be taken that the plugging is thoroughly done. If inadequate it will have to be repeated in a few hours—perhaps more than once—thus leading to exhaustion and setting up cellulitis, which may of itself be fatal, owing to the important relations of the kidney. One such case of retro-peritonæal cellulitis and suppuration, ending fatally, has been published; it is possible that other operators may not have been so candid. The position of the calculus having been made out it is removed by scraping through the kidney tissue with the finger nail or sharp spoon, and the stone turned out and removed with finger, dressing forceps, or scoop. Many difficulties may arise at this stage, due to the site, size, consistency, &c., of the stone.

If the stone is irregularly branched, some laceration of the kidney tissue may be spared if the stone is broken up and removed in two or more fragments. In this case the bed of the stone should be freely washed out with hot boracic acid lotion or Thompson's fluid,* so as to check oozing and remove all

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* Water, 4 oz.; glycerin, 4 oz.; borax, 2 oz. To be diluted with water to 1 in 10, or 1 in 4, according to the condition of the part syringed. Solutions of car-

*débris.** Mr. H. Morris (*Brit. Med. Journ.*, Nov. 16, 1889) thus alludes to two difficulties which these stones may cause. "A large branched calculus may be so tightly embraced by the kidney substance, and the kidney may be so uniformly even on its surface that nothing more than a very firm tough organ may be thought to be present, and even on passing a needle into it no sense of calculus, but rather the resistance of a tough fibroma, is met with. In these cases much difficulty will be experienced in freeing the stone from its encasement, and for this purpose the moderately free use of a bistoury will be requisite. It is astonishing how some of the large branches of a calculus may escape detection unless the surgeon is aware of the firmness with which they are embraced by the tough renal tissue. After removing several large pieces of calculus I have, in one or two cases, thought that all must have come away, because with my finger in the kidney nothing but renal tissue could be felt, and yet, after scratching through at some points where the resistance was greater than elsewhere, branch after branch of calculus has been exposed, showing that more of the calculus would have been left behind than had been removed had the operation been discontinued, because no further actual contact with the calculus was made with the finger in the interior of the kidney."

If the stone is situated on the anterior aspect near the centre of the kidney where the large vessels lie, the posterior aspect of the kidney or its pelvis had better be incised, and the stone pushed through, by making pressure on the front, the vessels here thus running no risk. Pelvic stones, the most frequent of renal calculi, are, however, usually accessible from behind.

If the kidney be enlarged with expanded calyces the result of calculous hydro-nephrosis or pyo-nephrosis, on searching through the pelvis over a stone, the gush of fluid and collapse of the expanded kidney may cause the stone to disappear, and thus lead to much trouble in its removal (Symonds, *Clin. Soc. Trans.*, vol. xviii. p. 181).

Mr. Morris (*loc. supra cit.*) gives two other conditions which may prove embarrassing. "Sometimes in feeling over the kidney

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bolic acid or mercury perchloride should be avoided in such cases, for fear of irritation or absorption. The temperature of the fluid should be about 110°.

* Mr. Kendall Franks (*Lancet*, 1880, vol. ii. p. 1223) thus removed, piecemeal, a friable stone weighing 171 grains, and composed of lime carbonate and phosphates. In this case the urine had been fetid, though acid. The wound healed by first intention. In cases of piecemeal-removal of calculi, especially when friable, a certain amount of doubt will often remain as to the entire removal.

a portion of it, varying in size from a sixpence to a five-shilling piece or more, is found soft, flaccid, thin or fluctuating, and there is nowhere any sense of hardness or increased resistance, such as might be expected from even a phosphatic stone. On incising or puncturing this soft part, pus or purulent urine is drawn off, but no stone is felt; but on introducing the finger into the interior of such an organ, a small calculus may be detected, freely movable within an enlarged pelvis, or fixed in a dilated calyx, or possibly at the apex of a funnel-shaped pelvis. Such cases show that aspiration, or simple incision and drainage, are insufficient, and that one ought not to be satisfied with anything less than a digital examination of the interior of the pelvis, of the calyces and commencement of the ureter. Another arrangement of the calculus is sometimes found in sacculated kidneys. The renal cavity may be wholly or partially filled by a soft mortary phosphatic calculus which gives no sound or resistance to the scalpel or trocar, and yet, on incising the renal substance and inserting the finger, a stone of considerable size may be felt."

If the kidney has been much disturbed during the operation it should be stitched *in situ* (p. 756). And it is possible that this step, taken earlier during the operation, might facilitate matters—*e.g.*, when multiple stones are present, and the kidney movable.

When all the stone has been removed, if free oozing continues from the kidney, a full-sized drainage-tube should be introduced to the very bottom of the wound, and actually into the kidney itself; if this has been much lacerated, or if it has contained pus, strips of sal alembroth or iodoform gauze should be carefully packed into the wound in the kidney. These should be removed in twenty-four hours, ether or gas being given for a few minutes, and re-introduced, less firmly, if needful. I have used this method in seven cases, in which my exploration of the kidney had been considerable, and without any bad symptoms.* For dressings I generally use dry iodoform or sal alembroth gauze with boracic lint outside, kept *in situ* with a many-tailed bandage. Salicylic wool or wood wool are efficient substitutes. Whatever dressing is used will have to be changed two or three times daily, for, in all probability, three or four days, owing to the soakage of urine. To reduce the irritation of this to a minimum, the parts around the wound should be well smeared with eucalyptus and vaseline. By means of pillows against the shoulders and pelvis, the patient should be kept off the wound, otherwise discharges will quickly soak out of the dressings, and the drainage-tube will irritate the wound.

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* If such plugging has to be made use of, it should be carried out effectively and once for all, otherwise recurrent bleeding and repeated plugging is very likely to lead to cellulitis, which may end fatally, to say nothing of the painfulness and shock caused by repetition of plugging, unless an anæsthetic is given.

A stone may be missed at the nephro-lithotomy and come away from the wound, and be passed later on per urethram. An instance of the former is given by Mr. Bruce Clarke, *Illus. Med. News*, p. 4. The latter happened to me in case No. 10 in the subjoined table.

After-treatment.

The chief points here are :

1. The meeting of shock after a prolonged operation.

2. Changing of the dressing at sufficiently frequent intervals at first, according to the amount of urine and blood which soak through.

3. Gradual shortening of the drainage-tube instead of entire removal, especially where there has been much interference with the surrounding parts, or where pus, &c., have been present in the kidney.

4. Avoidance of all chills.

5. Appropriate food, mainly the blandest fluids in regulated amounts, especially where the condition of the other kidney is doubtful.

Lastly, it may be pointed out that the life-histories of these cases should be followed up most carefully, to see how far the cure remains a complete one ; to aid this, the patient should pay life-long attention to his diet, habits, exercise, &c.

Difficulties in Nephro-Lithotomy.

1. An insufficient incision.

2. Abundant fat—*e.g.*, in the subcutaneous tissues, around the kidney, and extra-peritoneal, rendering the wound very deep.

3. Rigidity, and perhaps thickening, of the muscles, due to the irritation of the stone. This condition was present in a very marked degree in a patient from whom I removed the smaller calcium-oxalate calculus (Fig. 118). No amount of anæsthetic seemed to have any effect on this condition. Fortunately the loin was a thin one, and the stone very obvious on reaching the pelvis.

3. Matting of the parts around the kidney, rendering it difficult to explore this organ, its different parts and relations exactly.

4. An indurated condition of the kidney itself from the irritation of a stone.

5. Troublesome flatulent distension of the colon. This is not

at all uncommon. The bowel should be packed away with sponges fastened on to silk, and pushed deeply into the front of the wound.

6. Opening the peritonæum. This accident occasionally occurs in difficult cases. If the wound be kept aseptic, there will be no serious consequences. In case 11 of the series below, I opened the peritonæum under the following circumstances. The week before, in No. 10, the kidney lay very high up under the ribs. In No. 11 it was placed very low, closely surrounded by the colon, and with its lower end in the iliac fossa. It was also the seat of a small hydro-nephrosis, and therefore soft and yielding. On slitting up the lumbar fascia the descending colon came into view with a soft mass behind it which I took for pultaceous fæcal contents. I accordingly explored with my finger higher up, under the ribs, found a body firm and fleshy, with a feel like the kidney, but too small. This proved to be the spleen, unusually movable. The opening in the peritonæum was kept covered by aseptic sponges, and the mass behind the colon investigated. This proved to be the kidney, extremely low down, containing a calculus in the pelvis, this being also distended with fluid. For the first seven or ten days I kept strips of sal alembroth gauze, changed two or three times in the twenty-four hours, tucked up under the ribs, and stitched the low lying kidney well up into the wound, so that the urine should escape freely. The patient recovered without a bad symptom. A smaller opening might be tied up with chromic gut.

7. A stone present, but very difficult to detect. This may be due to (*a*) its small size, especially if it lies deeply in a calyx, or surrounded by very indurated kidney-tissue. How impossible it is to detect some stones, even when of fair size, is shown by a case published by Mr. Morris,* in which this authority, with all his experience, after thoroughly exploring the kidney, compressing it all over with the finger and thumb, and also after puncturing it, failed to detect a stone which lay in a hollowed-out calyx. Though the calculus was the size of a small marble, it was so thickly surrounded by kidney-tissue, that, even after the removal of the kidney, the position of the stone could not be detected by pressing on the kidney with the fingers as it lay on a table. The patient made a good recovery. (β) A sacculated kidney, into one of which sacculi a small stone may fall and be hard to find (p. 717).

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* *Med.-Chir. Trans.*, vol. xlviii. p. 69. The woodcut (p. 73) shows well the relation of the stone to the surrounding kidney.

8. A stone on the anterior surface of the kidney, especially if near the entrance of the vessels (p. 717).

9. A very large or a branching stone (p. 716.) Mere size does not necessarily create difficulties in extraction, though, owing to the changes entailed in the kidneys, the general health, &c., by the long duration of a calculus, the prognosis is rendered very much less favourable. Thus, in the calculus (Fig. 118) weighing 473 grains, or very nearly an ounce, the very bulk of the stone rendered its detection easy; it was readily loosened from the much dilated pelvis with lithotomy-forceps. A branched calculus presents, of course, much greater difficulties. Mr. Bennet May has published (*Clin. Soc. Trans.*, vol. xvi. p. 90), an excellent instance of this kind, in which he successfully removed a very large somewhat S-shaped calculus from a man aged thirty-four, with symptoms of sixteen years' duration. Though the stone weighed 473 grains, and was three inches long, manipulation failed to make it out distinctly, but acupuncture detected it at once.

10. A stone which breaks up readily (p. 718). Another condition allied in difficulty is where a calculous deposit rather than a distinct calculus is present. This is especially grave, as the deposit here will usually be phosphatic, and point to co-existing pyo-nephrosis.

11. Multiple calculi, as in the case at p. 722.

12. A very mobile kidney. The importance of having an assistant to push the kidney well up into the wound has already been insisted on. It is essential to have this done both for detection of the stone and for its removal, in order to avoid needless disturbance of the surrounding parts, or the kidney may be secured with sutures at the commencement.

Mr. May (*loc. supra cit.*) explains the remarkable fact that his large stone was not felt when the kidney was thoroughly exposed by the fact that the organ fell forwards and thus embarrassingly increased the depth of the wound.

13. A kidney situated very high up under the ribs (p. 720).

Question of Nephrectomy during a Nephro-lithotomy.—In several of the above conditions the question of the advisability of removal of the kidney will arise, *e.g.*, where the kidney has been much handled and repeatedly incised, where the stone is large and branched and difficult of removal, where many stones are present, or where one is present and very friable, where the kidney is much altered by pyo- or hydro-nephrosis, and finally where the surgeon is certain a stone exists but cannot find it, as in Mr. Morris's case already alluded to at p. 720.

In such cases the surgeon will be guided by the age of the patient; the knowledge he possesses as to the condition of the other kidney (the amount of urine, the percentage of urea, &c.); the degree to which the kidney he is operating on has been disturbed from its relations, and its structure interfered with; the amount of disease, *e.g.*, number of sacculi, condition of pus contained in them, the thinning of the cortex, &c. When the surgeon is certain from the history and failure of previous treatment that a stone exists which cannot be found, he must be chiefly guided by the degree to which life has been made miserable. Finally, the length of time that the operation of nephro-lithotomy has already lasted, and the condition of the patient must be taken into account. Where the patient is young, where the other kidney is healthy, where the kidney operated on is much damaged either by previous disease or by manipulation added to disease, where several stones are present, nephrectomy either now, or a little later, is indicated; of these immediate removal of the kidney is preferable if the patient's condition admits of it.* But the question is a very different one where the kidney is a large one after its fluid contents as well as a stone have been removed; or where it is a case of multiple calculi in a suppurating, damaged kidney. Nephrectomy should, as a rule, be deferred here, and the kidney thoroughly drained, for (1) additional shock and loss of blood will be avoided. (2) The condition of the opposite kidney, very possibly calculous also, will be made clearer by waiting. (3) The bulk of the kidney will be lessened by drainage. (4) Though a source of discomfort (if an open sinus persist) it may still do some and important work.

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* An instructive case which was under my care illustrates well many of the above difficulties—viz., multiple and large calculi, a mobile kidney, the question of nephrectomy arising during nephro-lithotomy, and the formation of multiple calculi in one kidney without symptoms. In February 1888 I was asked by Dr. Goodhart to see a case of probable renal calculus. The boy, aged fifteen, had been admitted with abdominal pain and grating of an indistinct and delicate nature in the left renal region. This kidney was slightly enlarged. When asked to localize his pain, the patient pointed to the region of the *left* kidney and the *left* loin. This kidney being explored was found to be occupied by irregular nodulated masses. A hare-lip pin at once came on and between calculi. The kidney being incised, hosts of calculi, comparable only to a gravel-pit, were found in the calyces and pelvis, the chief nests being at the upper and lower extremities. The former of these, lying as they did high up under the ribs, gave much trouble. To get at them the kidney-tissue was again scraped through directly over them, and many of them thus reached. The chief difficulty of the operation, in addition to the number of stones, was the great mobility of the kidney, though this organ was well pushed up from the front. The condition was perhaps due to the almost entire absence of surrounding fat. When I realized the condition of the kidney, I expressed myself in favour of nephrectomy, as the organ was almost useless, as the stones were so numerous, and as a prolonged attempt at removal would produce more shock in so weakly a subject. One or two less important points in favour of nephrectomy were the mobility of the kidney and entire absence of adhesions. Dr. Goodhart's counsel was, however, against this step, owing to the small percentage of urea—this had never been above 1.2 per cent., and often less. I accordingly continued; when forty-six calculi had been removed, and the operation had lasted three-quarters of an hour, the pulse failed so ominously that I was obliged to desist. Very little blood escaped as long as the opening was plugged with the finger, but considerable oozing followed as the finger brought out the stones. The patient never rallied well, and died three hours and a half after the operation. *Post-mortem:* There was a little ecchymosis

Causes of Death after Nephro-lithotomy.—Very few unsuccessful cases have been published; the following appear to be most probable causes of after-trouble:—

1. Hæmorrhage. A most interesting case of hæmorrhage, fatal on the seventh day after nephro-lithotomy, was brought before the Clinical Society (*Trans.*, vol. xxii. p. 214), by Dr. Stevenson and Mr. Butler Smythe. Several small and one larger stone (this one being tightly fixed in the pelvis and ureter) having been removed from a kidney, the site of hydro-nephrosis, the patient did well, save for a temperature which was 103° on the third and fifth days, and all along very variable, until the sixth day, when bright blood and urine were passed both by the urethra and by the wound. On the seventh day about half a pint of bright bloody urine was drawn off from the bladder, and death took place soon after, with symptoms of internal hæmorrhage. The kidney was found enormously distended with blood-clot and bloody urine. The opening made at the operation was small and blocked up by clot. Embedded in the kidney substance, close to the pelvis, was a round spiked calculus, which had ulcerated into a branch of the renal artery just at its entrance into the kidney, and had given rise to profuse bleeding into this dilated organ.

2. Cellulitis. If it has been thought needful to incise the kidney freely, and the bleeding has been arrested with difficulty after imperfect and repeated plugging (p. 718), this may be readily brought on. Other causes of this will be found in much disturbance of the wound or fingering by many hands. Sepsis.

3. Uræmia, if the other kidney is the site of calculous disease or

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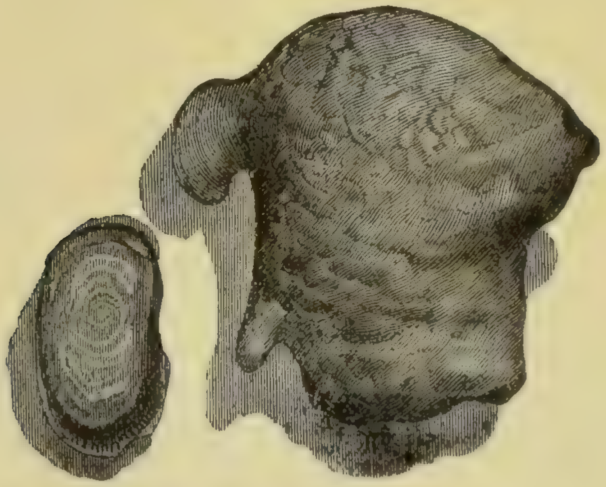
around the left kidney; it still contained calculi at its upper and lower parts. The *right* kidney, of which the boy had never complained, also contained a large number of stones. Its substance, though much wasted, still contained a fair amount of secreting substance. The condition of the opposite kidney thus abundantly justified my old friend's opinion. Feeling that unsuccessful cases of nephro-lithotomy have not been sufficiently published I brought this and the case at page 724 before the Clinical Society. A detailed account of each will be found, with two others, in the *Transactions*, vol. xxii. p. 198.

disorganized. This was chiefly the cause of death in the case in which I removed the large stone (Fig. 118). The patient was a solicitor, aged fifty-eight, of sedentary life, and gouty history, who had suffered from attacks of right renal colic off and on for upwards of thirty years, these attacks having become increasingly fierce for the previous six months. Occasionally he had had slight pain on the left side, and on the morning fixed for the operation he passed two small, fawn-coloured calculi of lithic acid and lithates. These were quite insufficient to account for all his suffering, and as prolonged and careful treatment had entirely failed, and as his "life was not worth having at the price," the operation was proceeded with, and the huge renal calculus figured below removed. This was effected with the utmost ease, as the stone, from its size and hardness, was readily detected occupying the distended pelvis of the kidney. A profuse jet of venous blood followed its removal with lithotomy forceps, after it had been loosened by a scooping movement of the finger. The hæmorrhage was at once arrested by sponge-pressure kept up for a few minutes. All went well for the first week, save for persistent oxaluria, which no treatment could remove. The patient was able to sit up and read; appetite returned, and the wound was healing well. On the sixth day a change for the worse set in, first much flatulence and nausea, then constant restlessness, followed by coma, ending in death on the morning of the eighth day. I cannot doubt that the opposite kidney was here also the seat of stone, and its tissue too much impaired to

FIG. 118.



The larger calculus is the one mentioned here in the text. It weighed 473 gr., and consisted of lithic acid and lithates. The main mass lay in the dilated pelvis, the processes fitted into the calyces. The smaller calculus, composed chiefly of oxalates, was successfully removed from a patient aged twenty-four. It weighed 42 grs. The two are good instances of what nephro-lithotomy can, and what it cannot do, without grave risks.

admit of recovery, though I was unable to obtain a post-mortem examination to verify this. I should add that the urine in this patient before the operation was acid, of sp. gr. 1018, and without sugar or albumen. The quantity passed was natural, and the urea sometimes normal, sometimes slightly deficient.

Dr. Whipham and Mr. Haward (*Clin. Soc. Trans.*, vol. xv. p. 123) have recorded a case in a patient at fifty-six—who had for "several years" been troubled with "gravel." The symptoms here were chiefly indicative of calculous mischief in the left kidney, but there was some tenderness on the right side as well. The urine here was 1006 sp. gr., alkaline, and containing pus. The left kidney was explored, and found in a state of pyo-nephrosis, no calculus was found, but a copious discharge of pus took place soon afterwards, giving great relief. The patient a little later again lost ground, and the wound was thoroughly explored a second time, but the patient sank a few hours after this, a month after the first operation. The left kidney pelvis was much dilated in its upper part, and communicated with a large peri-nephritic abscess. The right kidney contained a large branching calculus.

Both this case and my second one point urgently to the importance of surgeons being permitted to explore earlier in such cases.

4. Septicæmia. This condition may be induced by the wound becoming foul, a complication which can always be prevented after removal of small stones from healthy kidneys. But where pyo-nephrosis exists, it may be impossible to keep the wound sweet from the first. This was so in Case 6 of the subjoined table. Here, after removal of nine calculi, I was obliged to remove the kidney a year later, owing to the persistence of a fetid sinus. And it is to be noted that septicæmia may occur after a nephro-lithotomy, successful as far as the removal of the stone goes, after a considerable interval, where pyo-nephrosis coexists. This is an additional reason for carefully considering the advisability of performing nephrectomy in such cases.

Dr. Shepherd, of Montreal, has published* a very interesting instance of this kind. Nephro-lithotomy was performed in a patient aged twenty-six, who had suffered from symptoms of stone for seven years, with no tumour, and pus in the urine. An enormous, unbreakable stone of triple phosphate was removed with much difficulty from the left kidney. It weighed 4 oz. and 7 dr., and measured 3½ inches in length and 9 inches in circumference. The tissue of the lower part of the kidney exposed seemed healthy, and no pus being evacuated it was thought best not to remove the organ. The wound continued to discharge pus, and the temperature varied correspondingly for three months and a half after the operation, when septicæmia set in and proved fatal. The autopsy showed that the upper part of the kidney, which was not exposed, consisted of large communicating sacs, containing over 10 oz. of fetid pus, and a number of irregular branched calculi. Dr. Shepherd points out that the fatal septicæmia was undoubtedly due to these abscesses, showing the need of thorough exploration in all cases where a large stone has set up grave changes, and of extirpation in most of them.

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* *New York Med. News*, April 23, 1887; *Annals of Surgery*, vol. vi. August 1887, p. 185. The condition of the opposite kidney is not mentioned.

I have described lumbar nephro-lithotomy fully because I believe that, on the whole, it is the safer operation for the great majority of operators. But, to make the account complete, reference must be made to the proposal that **abdominal** should replace lumbar **nephro-lithotomy**.

As might be expected, this proposal has come from a specialist in abdominal surgery. Mr. K. Thornton (Harveian Lectures, "Surgery of the Kidneys," p. 34) gives the following reasons for preferring his combined method:—Recognising the difficulty in the diagnosis of a stone, and the still further complication introduced by the transference of pain in some cases to the opposite side, and the importance of being able to examine the other kidney and both ureters thoroughly, throughout their whole course, I proposed to open the abdomen by Langenbüch's incision over the suspected kidney, examine carefully both kidneys and ureter, and, having found a stone, to employ one hand in the peritonæum to fix the kidney and stone, and guard the colon, while with the other I could cut down upon the stone directly from the loin, merely making an opening through the loin tissues large enough to introduce the finger and necessary forceps for the extraction of the stone." And again, at p. 36: "We are certain that the patient has the usual allowance of kidneys. The chances of overlooking the stone, if there is one present in either kidney, is reduced to a minimum. I do not say that the abdominal handling is absolutely infallible, but in fourteen operations I have only once failed to find a stone, and the recovery and present health of this one patient make it highly improbable that there was, or is, a stone in her kidney. This result compares very favourably with the large number of unsuccessful lumbar explorations already recorded."

No one who has seen much of lumbar nephro-lithotomy would allow the above remarks to pass uncriticised.

While I am fully aware of the difficulties in determining whether a stone is present, and in what part of the kidney it lies, I am convinced that every year that goes by will perfect our power of diagnosis, by making clearer to us the conditions that simulate stone. "The large number of unsuccessful lumbar explorations" of which Mr. Thornton makes a strong point is not quite correctly referred to by him. He implies that a stone was there, but that operators making use of lumbar nephro-lithotomy failed to find it. Now, this is not quite the case. In the great majority of cases no stone was present. They were cases in which the diagnosis was at fault. It has always been so with every new operation, and is one of those faults which time alone puts straight. In reality these failures to find a stone are rather creditable to the lumbar operation. The operators have been of the most varying degrees of experience, and the great majority of their cases * have recovered. Would this have been the case if the explorations had been through the peritonæal cavity with "the necessary manipulations to examine the kidneys and ureters?" Now, on this hangs one of my chief points. No one who knows anything of what Mr. Thornton has done for abdominal surgery will doubt for a moment that operations on the kidney through the peritonæum are certain to be as safe in his hands as any operation can be. But what this book has to try and teach is what operation is the safest for the largest number of operators. I cannot agree with Mr. Thornton that the increased risk due to the opening of the peritonæum is practically nil—*i.e.*, if the surgeon will take the pains to perform a thoroughly aseptic operation. I should agree that the risk of peritonitis is now "practically nil," but there are other risks which are inseparable from this mode of exploring the kidney.† I refer to the shock which the necessary manipulations of certain very vital parts must entail. Mr. Thornton will be able to go straight to the kidneys with a minimum of disturbance of the overlying parts. But is it to be believed for a moment that this would be the case with the majority of operators? And this brings me to another point. Others who have tried this method have not found it so easy to detect the presence of a renal calculus or to determine the condition of the kidneys. Thus, with regard to the latter point, a few months ago a woman was sent to me with long-standing pyuria of renal origin. She was clearly very near her end from kidney failure, and during the five days she lived no operation was admissible. After her death I thought it a good opportunity to investigate the condition of the kidneys by an abdominal incision. I was able to feel that there was a right kidney, which felt so hard that I thought it contained a stone. About the condition of the left kidney I was quite unable to satisfy myself. The post-mortem examination showed that the right kidney was in a condition of fibroid atrophy; no stone was present. The left was a thin walled sac containing pus. Owing to the great tenderness on this side, I had looked on this kidney as the source of the pyuria. It would have been readily reached from the loin.

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* I have pointed out (p. 723) that there is reason to fear that fatal cases have not been published. But this would not apply to the lumbar operation only.

† Every one who has seen much of renal surgery will know that grave shocks may readily be met with in some of these explorations of the kidney. Thus, in my last nephro-lithotomy (No. 12, table 7, p. 732) in a lady of forty, with fifteen years' history, from whom I removed three cystine calculi, the patient was so anæmic and unhealthy from her long-continued pain and marred life, that she nearly succumbed during the operation. Yet this was of the simplest, the loin thin, the calculi (387 gr.) found at once and extracted easily, the operation itself not exceeding twelve minutes. A.C.E. followed by ether had been given, but the pulse, always weak, became almost imperceptible after the first incision.

But I would rather quote the opinions of others. Mr. T. Smith (Discussion at the Clinical Society, *Brit. Med. Journ.*, 1887, vol. i. p. 393) said that Mr. Thornton had seemed to represent that by opening the abdomen from the front one could ascertain with certainty whether there was a stone in the one or other kidney. But one could not always tell this, even if one felt the kidney out of the body. In three different cases in which he had handled kidneys so removed no stone could be detected therein until the kidneys were cut open.* Another very interesting case brought by Mr. Page before the Medico-Chirurgical Society (*Brit. Med. Journ.*, 1888, vol. i. p. 795) shows what care is needed when abdominal exploration for the examination of kidneys is made use of. Mr. Page thought that in this case abdominal exploration, had he made it, would probably have led him astray, as the left kidney, which, though small, was the working one, would have been removed, while the right viscus, which was really the seat of pyelitis and contained some small stones, would have been looked upon as merely enlarged to do the work of two, this increase in size being really due to its diseased condition.

Mr. K. Thornton (p. 37) mentions a case in which it took an hour to find the kidney by the lumbar incision, and which ended fatally, and another in which the surgeon failed entirely to find the kidney by the same method. Such cases, as shown by their number, are quite exceptional. When the large number of explorations of the kidney by the lumbar method is considered, it will be acknowledged that the lumbar method is characterised by the ease with which the kidney is found and the well-doing of the cases afterwards, especially when the great number and the diversity of operators are considered.

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* On this point see Mr. Morris's case, p. 720.

With regard to pain in one loin due to mischief in the opposite kidney, we have very little knowledge as to sympathy between the kidneys. But this condition is certainly rare. As a rule, in renal calculus pain is alone complained of on the side on which the stone lies. Pain in both loins means usually stones or disease on both sides, a far graver thing than " sympathy."

Mr. Thornton, in his combined method which I have described at p. 726, lays stress upon the small clean cut which is made upon the stone by the loin, only large enough to introduce the finger and forceps. It is difficult to see how such an opening would suffice to remove a small stone lying in a calyx on the anterior surface of the kidney, one of the most difficult of all cases. By the lumbar operation the surgeon would be able, after freeing the kidney, as is nearly always feasible, to bring it up into the wound, and carefully handle the anterior as well as the posterior surface. With regard to the risk of the hernia which Mr. Thornton states (*loc. supra cit.*) to be " a not uncommon result of the lumbar operation," the experience of most surgeons will be quite the opposite. As already stated (p. 696), the tissues in the lumbar region are so strong and unyielding compared with those in the anterior abdominal wall that a protrusion does not readily take place here.

CALCULUS IN THE URETER.

If the calculus is impacted in the lower orifice of the ureter, it may be extracted in the case of a woman, after dilatation of the urethra. If the calculus have lodged in the adjacent pelvic part of the ureter, Langenbüch's incision (p. 747) will be the best. Where the stone is situated in that part of the ureter which crosses the iliac vessels, a modified lumbar incision will remove it without opening the peritonæum.

The first case in which a patient has been saved from death by suppression of urine by the removal of a calculus low down in the ureter, is a brilliantly successful one, by a general practitioner—Dr. Kirkham, of Downham Market (*Lancet*, March 16, 1889). The patient was fifty-eight. He had twice suffered from right renal colic, and had passed a small calculus. May 24 left renal colic came on. No urine was passed from this date till after the operation. May 30 the patient was drowsy, with prostration and muscular twitchings. Dr. Kirkham then explored the kidney in the hope that if no calculus was removed life might be saved by affording an outlet to the urine by an incision into the pelvis of the kidney. An incision was made from the tip of the last rib towards the anterior superior spine. No stone being found in the kidney, the exploration was continued along the ureter, in which a stone was distinctly felt about ½ inch above where the ureter crosses the external iliac. There was a little difficulty in reaching the ureter in this part of its course, but after enlargement of the wound a calculus about the size of a date stone was removed. A little urine escaped from the incision into the ureter. No sutures were placed in this. Half an hour after the operation 1½ oz. of urine were passed naturally. Very little escaped from the wound in the ureter, and the patient made an excellent recovery.

Mr. Twynam of Sydney published (*Brit. Med. Journ.*, 1890, vol. ii. p. 240) a case in a child, aged eight, where he removed a stone lodged in the ureter, about 2 inches from the bladder, by an incision like that used for tying the common iliac. The wound was closed (with much difficulty by fine silk sutures), leakage of urine followed, with some suppuration, but a perfect recovery followed.

Dr. Ralfe and Mr. Godlee brought before the Clinical Society (*Trans.*, vol. xxii. p. 155) a case of suppression of urine, caused by impaction of calculi in both ureters, relieved by operation. The patient, a lady, aged twenty-six, had had attacks of renal colic on both sides. The left kidney* was first explored, and incised, but no gravel or calculus found. On passing the finger along the ureter a minute hardness was felt about 2 inches below the kidney. A stone having been verified by needle puncture, it was extracted by a small incision. No sutures were inserted, but free drainage provided. About a month later, as there was reason to believe that the right ureter was probably still obstructed, the kidney on that side was explored; no stone was found, but a considerable quantity of gravel and mucus was cleared away. The ureter was ascertained to be pervious as far as the iliac vessels by the finger and the passage of fine curved forceps. About two weeks later a small stone was passed. The patient made a good recovery. Mr. Godlee points out that in a case like this before operation the urethra should be dilated and the orifices of the ureters examined, for careful vaginal examination may fail to detect a comparatively large stone in this situation. He thinks that the parts of the ureter where stones are most likely to become obstructed are (1) the orifice, (2) the brim of the pelvis, and perhaps (3) about 2 inches below the kidney. Mr. Godlee has shown elsewhere that urine and pus and blood may escape pretty freely past a calculus of very considerable size which is lodged in the middle of the ureter.

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* Mr. Godlee points out that, as is the rule, the pelvis was little if at all dilated, and the amount of urine contained quite small: the function of the kidney is, in these cases, completely upset by the sudden stoppage of the ureter.

Mr. K. Thornton (*loc. supra cit.*, p. 31) met with two cases in which the stone was imbedded low down in the ureter. In one case, in which he removed the kidney, which was pyo-nephrotic and disorganized, he left the stone in the ureter with a perfectly successful result. In the other Mr. Thornton dilated the urethra, and cut the stone out through the bladder, but a ureteral fistula resulted, the urine was discharged into the pouch of Douglas. The woman went out of her mind, and died of exhaustion a fortnight later.

Mr. Lane has published (*Lancet*, 1890, vol. ii. p. 967) an instructive case of calculus removed low down in the ureter by Langenbüch's incision. A woman, aged twenty-three, had had symptoms of renal stone for twenty years, but there was nothing to point to the fact that the stone was in the ureter and not in the kidney, except that, associated with her renal pain, she complained at times of pain in the lower part of the abdomen on the same side, which did not appear to be reflected. The kidney was explored by the lumbar incision, and nothing found either in this organ or in those parts of the ureter which could be reached from above or per rectum. The pain having returned with its original severity, the abdomen was opened along the left linea semilunaris, and in the portion of the ureter which had not been explored at the previous operation, a small stone was felt. This was forced upwards along the ureter to the crest of the ilium, and by means of a small incision in the side the ureter was exposed, and the stone removed. The aperture in the ureter was sewn up by a fine continuous silk suture. No leakage took place from the ureter, and the woman recovered completely, losing all her pain and discomfort.

Bardenheuer was not so fortunate in a less favourable case (*Centr. f. Chir.*, March 1882, s. 185). The patient had had left suppurative pyelitis and perinephritic abscess. By an exploratory incision the kidney was found to be entirely atrophied. Suddenly, during convalescence, complete suppression came on. The other ureter having been exposed in the flank, a bean-like calculus firmly impacted was liberated, and the ureter sewn up. After temporary relief rigors and pyrexia followed, and Bardenheuer decided to reopen the wound, divide the ureter, and bring the upper end into the wound. A month after the operation the patient was doing well, but with an urinary fistula.

Twelve Cases of Lumbar Nephro-Lithotomy.

No.	Medical Men.	Age.	Sex.	Site of Stone.	Weight.	No.	Result and Remarks.
					grs.		
1	Dr. Hale White	23	M.	Pelvis	42	1	Recovery.
2	Dr. Wilson, Haverfordwest	58	,,	,,	473	1	Death ninth day. Almost certainly calculi in opposite kidney.
3	Dr. Goodhart	15	,,	Throughout kidney	652	46	Death three hours after, opposite kidney a "gravel-pit."
4	For Mr. Durham *	41	,,	Pelvis	78	1	Recovery.
5	Dr. Phillipps, Faversham	53	,,	Top of ureter	14	1	Recovery.
6	Dr. Newton Pitt	31	,,	Throughout kidney	333	8	Recovery with a sinus. Nephrectomy a year later. Recovery.
7	Dr. Todd, Brigg	29	F.	,, ,,	39	9	Recovery.
8	Dr. Cressy, Wallington	22	M	Calyx at upper part of kidney	22	1	Recovery.
9	Dr. Morley, R.N. Chatham	40	,,	?	—	2	I missed both these stones after free incision of the kidney (in two places) and sounding. Both descended a little later. One was passed, the other I crushed. The patient has been perfectly well since.
10	Dr. H. P. Berry, Grantham	33	,,	Pelvis	45	—	Recovery.
11	Drs. Fry and Clayton Jones, Shepton Mallett	28	,,	,,	49	—	Recovery.
12†	Dr. L. Stephens, Emsworth	40	F.	,,	387 Cystine	4	Recovery.

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* This case had been admitted under Mr. Durham, and I operated during his illness. It afterwards transpired that the case had been sent up to Mr. Lucas.

† Nos. 2, 7, 8, and 12, were private cases. I was responsible for the after-treatment of all except No. 7.

NEPHRECTOMY.

Indications.

i. Cases of strumous pyelitis or pyo-nephrosis explored previously and drained by nephrotomy, but in which a sinus and discharge persists. Here the kidney should be removed when the following conditions are favourable—viz., the age and strength of the patient, the absence of visceral infection, tubercular or lardaceous, and, if possible, a date not too long deferred, for the additional reason that the kidney will be increasingly matted down and difficult of removal, while its fellow may have become involved in the disease.

On this point I may quote again from my paper on the conditions which simulate renal calculus (*Brit. Med. Journ.*, 1890, vol. i. p. 117):—

"I would most strongly urge this step (early exploration of the kidney) with a twofold object: (1) to clear up the case, and (2) to perform nephrectomy if the kidney is found to be the site of so fatal a disease. If I am told of the unwisdom of this step, owing to the probability of both kidneys being affected, I would reply that, as a rule, both kidneys are not affected at an early stage. Thus Dr. Fagge (*Medicine*, vol. ii. p. 488) gives a list of thirteen cases which show 'the characters of tuberculous disease of the kidney at its commencement.' In only three of these were both kidneys affected, and in all these tubercular mischief was present in the bladder also. If during this early exploration one or two pyelitic dilatations are found, extirpation of the kidney should be performed while the organ is still small and movable, and before the rest of the genito-urinary tract becomes involved.

"I need not remind my hearers of the miseries which lie before a patient with established tubercular kidney, the results of ulceration of his bladder, with, perhaps, vomicæ in his prostate, and the inevitable course downhill—arrested, it may be, for a little while by nephrotomy and drainage.

"My own experience of nephrotomy in established tubercular kidney is most unfavourable, the relief being slight and short-lived, and not arresting long the hectic and increasing debility. On the other hand, in two cases in which I have been able to perperform nephrectomy early the result has been very satisfactory. One, a very frail woman, aged forty, operated on 3½ years ago, has remained free from tubercular trouble since; the other, a young man, operated on 3 years ago, has been able to complete his terms at Cambridge, and to take a curacy near Ipswich.* These cases are Nos. 3 and 4 in the table, p. 754.

ii. Calculous pyelitis or pyo-nephrosis where the kidney is destroyed by long formation of calculi and consequent suppuration, where numerous calculi exist with sacculation of the kidney, or where a large and branching calculus is so imbedded as to resist removal. These indications for nephrectomy have been already considered under the heading Nephro-lithotomy (p. 721), as it is during the performance of this operation that the question of removing the kidney for the above conditions will arise.

iii. A kidney the site of hydro-nephrosis. Aspiration, lumbar nephrotomy, and drainage, the edges of the cyst being stitched in the wound, and nephrectomy have, each, been advocated here. Occasionally repeated aspirations are sufficient, as in Mr. Croft's case (*Clin. Soc. Trans.*, vol. xiv. p. 107), in which eight aspirations (through the lumbar region) within four months, between three and four pints being withdrawn each time, sufficed to cure a hydro-nephrosis in a boy aged twelve. It is noteworthy that the case was distinctly traumatic in origin, and that the last fluid withdrawn contained a very large amount of albumen. It is for such cases, especially if the interval between the aspirations lengthens each time, that aspiration should be reserved. This method is, however, so rarely successful that the surgeon will usually have to decide between nephrotomy and drainage, and nephrectomy. It is now acknowledged by the advocates of the former step that it has given less favourable results than were expected. The time taken is usually very great, the frequent change of dressing necessitated by the constant soakage is most irksome, and later the wearing of a lumbar urinal is most inconvenient, leading as it often does to an eczematous raw area round the sinus. The sinus itself in one case of mine in which a year after nephro-lithotomy I removed the kidney (No. 6, table p. 732), and in another which I have seen, contained foul phosphatic material. The tube also, which leads into the urinal from the sinus, is liable to become blocked and cause much discomfort from redistension of the cyst.

In future, nephrectomy will be oftener performed for hydronephrosis where the kidney is much altered, either as a primary operation or after allowing a sufficient interval to elapse for shrinking of a large cyst, but no prolonged delay. Where, therefore, the patients are young, with every prospect of a long and active life before them, where one or two months' drainage have failed to bring about any considerable diminution in the amount escaping, and where the fluid thus coming away contains but a small amount of urine, and where there is evidence that the other kidney is competent, the cyst and remaining kidney tissue should be extirpated from the loin before it has become more firmly matted in the surrounding parts.*

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* About eighteen months after the removal of his kidney this patient began to show signs of tubercular mischief in his prostate and bladder. Dr. Brogden, of Norwich, writes (Feb. 1891): "There is practically no bladder or prostate trouble. Patient able to do his parochial work, preach, &c. During the frost has been skating and hockey-playing."

iv. Certain cases of malignant disease. These fall into two groups, which must be looked at separately from an operative point of view. One group, the *sarcomata*, occur in children before ten, usually much earlier, before five. In such cases the risks of immediate death from shock, aided often by peritonitis, of early recurrence, or of death from secondary deposits elsewhere, should be put clearly before the parents, together with the certainty of an early death if the growth is left.

The other group, the *carcinomata*, occurs usually in patients past middle age. Here the surgeon will be aided by the power of the patients themselves to come to a decision after the risks have been fully explained to them.

In either case, an operation should only be performed in an early stage, while the growth is still internal to the capsule, and while the strength, health, and condition of the viscera are satisfactory. On the other hand, where the history makes it probable that the growth has got beyond the earlier stage, when there is any extension to the lumbar glands or other viscera, when there is nausea, emaciation, or a temperature inclined to fall, the time for operation has gone by. So, too, any ascites or œdema of the lower limb are absolutely contra-indications. With regard to the frequency of secondary deposits, the fact that Dr. Dickinson † found these to be present in no fewer than 15 out of 19 cases strengthens, very decisively, the argument in favour of early operations while these growths are small, at which time, moreover, they can be successfully attacked through a lumbar incision sufficiently enlarged by the steps given at p. 741, or by one made anteriorly, as in the case quoted at p. 750.

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* If in hydro-nephrosis after an exploratory nephrotomy bloody urine descends into the bladder, the indication for leaving the kidney will be greater, especially if the viscus show a cortex of fair thickness, and is not a mere sac with little if any secreting tissue.

† *Dis. of the Kidney, and Urinary Derangements.*

Mr. Butlin (*Oper. Surg. of Malig. Dis.*, p. 254) thus speaks on the question of operation in these cases:—" The death-rate on the total number of cases is enormously large, more than 60 per cent., for carcinoma more than 71 per cent. Nor do I think that a study of the causes of death, whether made from the paper of Gross or from the reports of the individual cases, will lead to the opinion that there is a reasonable prospect of largely diminishing it, unless the diagnosis of the disease can be made at a much earlier period than it has been hitherto. The successful cases are, I am sorry to say, much more easily disposed of.* . . . . For the operations for sarcoma (from which fourteen survived) . . . . we may count two complete cures † in the total number of cases. It is interesting to observe that not one instance of cure, or even of long relief, is recorded in the cases of children.

" The results of the operations for carcinoma are even worse than those for sarcoma. . . . Four patients recovered from the operation, of whom two died of secondary growths within two months of their recovery; one was alive and well at the end of two months, the other at the end of thirteen months." The following conclusions are thus drawn by Mr. Butlin:—" Nephrectomy for the removal of carcinoma has been so fatal and so thoroughly unsuccessful that the results do not appear to justify a continued trial of the operation. Nephrectomy for the removal of sarcomatous kidney in children has not been so fatal as for carcinoma in adults; but not one thoroughly successful result can be claimed, and it is possible that the operation will fall into disrepute. Nephrectomy for sarcoma of the kidney in adults has hitherto afforded the best results, but the successful cases are so few, and the mortality is so large, that the operation is not likely to find favour in the eyes of either surgeons or patients."

Mr. Knowsley Thornton, in his Harveian Lectures for 1889, writes thus on the subject: " If we now attempt to summarise our imperfect knowledge of renal sarcoma, we find that it is most common in children, is in them often congenital, in this case going on to a rapidly fatal termination; that when it makes its appearance later, but still in childhood, it runs a much more rapid course than in the adult, more speedily involves surrounding tissues, and is therefore rarely seen at a time when operation can be undertaken with any reasonable chance of eradicating the disease; that even when detected quite early and before there is any sign of its having involved the other tissues, its removal is commonly followed by such speedy recurrence that the operation is barely justifiable. Such recurrence, moreover, is very extensive in its outbreak, and usually leads to an amount of suffering altogether beyond that which is seen when the disease is allowed to run its natural course in the kidney. Turning now to the adult, we find that the disease is most common in the middle period of life, is usually slow and insidious in its early course, and frequently progresses slowly, and often painlessly for years, before it spreads beyond the kidney, occasional attacks of hæmaturia, and a hard swelling in the renal region, which is, from its weight, apt to become more mobile than a normal kidney, and is therefore likely to be regarded as an innocent condition, being the only symptoms which are at all common. It is worthy of special note that with the two large tumours of the capsule (or of the supra-renal capsule) there was no hæmorrhage; indeed, the only symptom in each case was the tumour, till its size caused indigestion, nausea, &c. There was never any urinary symptom in either case to direct attention to the kidney."

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* Mr. Butlin, quoting in detail from Prof. Gross (*Amer. Journ. Med. Sci.*, July 1885), thus specifies the results in the cases of the fourteen survivors: " One died of an unknown cause; one was living with recurrence at the end of four months; and five died of the disease in from five to eighteen months of the operation; two were lost sight of; and five were alive and well at the end of seventeen, twenty-two, twenty-three, thirty-five months and five years. The thirty-five months may fairly be stretched to three years, so that we can count two complete cures in the total number of cases."

† Mr. Butlin means by complete cures that these cases were alive and well at the end of three years after the operation.

With regard to carcinoma, Mr. Thornton thinks that the pain radiates more in this than in sarcoma, and that carcinoma is usually sensitive to the touch, which is rarely the case in sarcoma. As stated by Newman, however, the difference in the symptoms of the two is one of degree rather than of kind.

The main point with regard to future treatment here appears to me to be this, that when a case shows signs of renal malignant disease—viz., a steadily growing swelling in the position of the kidney, with perhaps hæmorrhage and pain—the doubt should be early cleared up by an exploratory lumbar incision, to be converted, if need be, into one for nephrectomy by the additional incisions given at p. 741. For such cases alone, in their early stage, will the wise surgeon be at all inclined to urge an operation.

v. Certain cases of injury. These are very rare, and fall into the following groups:—(*a*) Where an injured kidney protrudes from a wound of the abdomen, usually the loin. (*b*) In some cases of non-penetrating wound of the kidney, as when it is ruptured from a fall or blow. (1) Where hæmaturia does not yield to treatment,* the bleeding being well marked, or latent and insidious, giving evidence indirectly of its existence, by the increasing pallor, the failing pulse, impending syncope, and perhaps a swelling in the loin. (2) Later on, when the injured kidney is setting up serious suppuration, which does not yield to nephrotomy and drainage, or where, during an exploratory nephrotomy, the injury to the kidney is found to be very severe, *e.g.*, a transverse rent. (3) For ruptured ureter, Mr. Barker has recorded (*Lancet*, Jan. 17, 1885) a most successful case, in which, after other treatment had failed, he removed a kidney three months after the rupture. The child, aged three and a half, had been run over, but beyond some bruising and one small clot passed there was nothing to point to injury of the urinary tract. Having left the hospital in a fortnight, ap parently convalescent, he was, a few days later, admitted with a fluctuating swelling in the right loin. This increasing, was aspirated, the fluid yielding ½ per cent. of urea. The swelling was subsequently drained, and the drainage-tube becoming blocked with phosphatic deposits, and thus causing a good deal of constitutional disturbance, the kidney was removed. It proved to be healthy, the ureter being torn across just below it. (*c*) Penetrating wounds. Very rarely indeed nephrectomy may be called for here (1) when hæmorrhage does not yield to treatment aided by exploration and plugging; (2) when a urinary fistula persists after such a wound in certain cases—*e.g.*, when the other kidney is healthy. (*d*) Gunshot wounds. Owing to the increase of revolver-injuries and recent advances in abdominal surgery, this matter has lately received much attention.† Whether in civil or military practice, gunshot wounds of the kidney are only too likely to be complicated with injuries of the intestines, liver, and spine. When in the course of an exploratory operation in the case of a gunshot wound of the abdomen, the kidney is found to be the seat of hæmorrhage, uncontrollable by other means, nephrectomy should be performed (p. 796).

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* In Mr. Rawdon's case (*loc. infra cit.*) nephrectomy was performed for hæmorrhage after an injury, but at rather a later date—*e.g.*, on the seventeenth day after the fall—to prevent blood from entering the bladder and increasing the acute cystitis present. Here the hæmaturia had diminished at first, and then subsequently increased.

† As might be expected, American surgeons have not been slow to avail themselves of their opportunities. Prof. Nancrede (*Annals of Surgery*, June 1887, p. 480) suggests that where the renal or splenic artery is cut by a bullet, the viscus should be removed, as gangrene is inevitable. Dr. Parkes (*loc. supra cit.*, November 1887, p. 379), in a case of bullet-wound of the abdomen, having sewn up five perforations of the intestine, found that the left kidney was perforated. The hæmorrhage was very slight at this time. After doing well for twenty-four hours, the patient began suddenly to fail, and died collapsed from hæmorrhage from the kidney. Dr. Parkes regretted that he had not performed nephrectomy.

(vi.) In a few cases of nephrorraphy. Where, after nephrorraphy, the mobility of the kidney is not much diminished, still less abolished; where there is much real pain, nausea, inability to carry out the duties of life, nephrectomy may be resorted to if the condition of the opposite kidney admits of it. In a few cases nephrorraphy will fail, owing to the complication of organic disease, as in the instance at p. 757.

Operations.

These are. A. **Through the Lumbar Region.** B. **Through the Abdominal Wall, and the Peritonæum as well.** (*a*) By an incision at the outer edge of the rectus. (*b*) By one in the linea alba. C. **Through the Abdominal Wall, without opening the Peritonæum.** These methods are compared at p. 751. D. **Knowsley Thornton's combined Method.**

A. Lumbar Nephrectomy.

Operation.

The position* of the patient and the earlier steps are much as those already given in the account of Nephro-lithotomy, p. 713.

When the lumbar fascia has been slit up and the fat around the kidney torn through, this organ should be well thrust up by an assistant making careful, steady pressure with his fist against the abdominal wall: the wound being now widely dilated with retractors, the surgeon examines the kidney, and has next to decide on three points:

(1) Is removal required?†

(2) Will more room be wanted? If so, the incision already made slightly oblique and about ½ inch below the twelfth rib, should be converted into a T-shaped one by another made downwards from its centre, or at its posterior extremity, along the

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* Additional care should be taken to open out the space between the last rib and the crest of the ilium by the arrangement of pillows underneath the loin, and precautions must be taken here to avoid shock—*e.g.*, bandaging the limbs in cotton-wool, having only the site of the wound exposed, keeping the head low, having injections of brandy or whisky ready, and giving ether or the A.C.E. mixture. An assistant should occasionally irrigate the wound with a hot solution of mercury perchloride (1 in 1000).

† This question has already been alluded to in the case of a strumous kidney incised and drained (p. 733); in that of a kidney much damaged by one or more calculi, under the subject of Nephro-lithotomy (p. 721); and in the case of hydronephrosis (p. 734).

outer edge of the quadratus lumborum. Additional room may also be gained by an assistant slipping his hand under the lower ribs, and drawing them forcibly upwards.

(3) Is the kidney firmly matted down or no? If there has been no surrounding inflammation, the extra-peritonæal fat, the peritonæum, and colon will be readily separated by the finger working close to the kidney until the pelvis and vessels are reached. But if inflammation has caused firm adhesion and matting down of the kidney to adjacent parts, the altered fat and thickened and adherent capsule must be divided down to the kidney itself, and this gradually enucleated (partly with the finger, partly with a probe-pointed bistoury) from out of its capsule which is left behind.

The only guide in such a case is the tissue of the kidney itself, close to which the finger and knife must be kept.

A case of Mr. H. Marsh's well shows this difficulty. Removal of the kidney could not here be effected, owing to its size and the firmness with which it was embedded in the surrounding condensed areolar tissue.* That part of the kidney which had been exposed was accordingly transfixed with a strong, double ligature, and cut away. Complete suppression of urine† followed the operation, and the patient died in about thirty hours. At the post-mortem examination the remaining part of the right kidney and its ureter were so firmly embedded in dense cicatricial material that they were dissected out only with difficulty. The kidney itself was converted into numerous sacculi, in the walls of which, however, some remains of renal structure could still be traced. The opposite kidney weighed 6 oz. Its capsule was adherent, and there were two or three more cysts on its surface. On section, its structure looked somewhat confused and cloudy, but its condition was not such as to indicate advanced disease.

Mr. Greig Smith states (*Abdom. Surg.*, p. 508) that, in cases of old-standing suppuration with great enlargement, the vena cava and the aorta may be intimately adherent to the capsule. "One such case was met with in the post-mortem room of the Bristol Infirmary; here it was simply impossible, after death, to dissect apart the venous wall and the renal capsule. In another case, for similar reasons, the organ could not have been removed by any proceeding claiming to be recognized as surgical."*

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* Mr. Marsh (*Clin. Soc. Trans.*, vol. xv. p. 142) points out that the state of the kidney here proved to be much worse than there had seemed reason to anticipate. Although it had been impossible to feel it in a very careful examination under ether, it was dilated to a very large size. Mr. Marsh further thinks "it very doubtful whether it will not ultimately be found that the safest way of removing the kidney is by abdominal section through an incision just external to the rectus," as "the lumbar incision does not afford sufficient space for the removal of a kidney of large size, or of one that is firmly bound down by adhesions." It is not, however, stated whether the lumbar incision made use of by Mr. Marsh, "an oblique incision in the loin," was prolonged forwards freely (p. 741), and still further room given by converting it into a T incision.

† The urine had been horribly fetid, and the sp. gr. never above 1015.

If further room is still required, this may be easily and effectually gained by making use of additional incisions as recommended by Prof. König, of Göttingen (*Cent. f. Chir.*, 1886, Hft. 35; *Ann. of Surg.*, Nov. 1886, p. 445). This surgeon, having found great difficulty in getting free access to the kidney by the ordinary lumbar incision, cuts through the soft parts vertically downwards along the border of the erector spinæ to just above the iliac crest. He then curves the incision towards the navel, and ends at about the outer border of the rectus, if necessary going through this muscle to the umbilicus. It may be often advisable to make the perpendicular cut oblique, running in a flat curve into the umbilical part. All the muscles are incised quite down to the peritonæum. This method gives a surprisingly free entrance, but it can be much improved by introducing the hand through the perpendicular part of the cut, separating the peritonæum in front and pushing it forwards. Prof. König proposes to call this the retro-peritonæal lumbo-abdominal incision. If sufficient space is not thus afforded, or if for diagnostic or operative purposes it is desirable to approach the tumour from the abdominal cavity, the peritonæum can be divided in the transverse cut. If infectious material is to be removed, this peritonæal opening must be carefully looked after. Two recent cases are given illustrating the second method. (1) Old pyelo-nephrosis, with a colossal calculus in the pelvis. The removal of the stone was only possible by the additional peritonæal opening. (2) Vesical catarrh with stinking pyelitis. Cure took place in both cases, except slight remaining fistulæ.

We do not yet know how far large kidneys can be got out through very free lumbar incisions. I may state here that I have twice this year (1890) removed kidneys 8 inches long through the very limited ilio-costal space of little children aged respectively three and three-and-a-half. One was a case of sarcoma, the other of cystic kidney. Both made excellent recoveries, but, as in the former, the renal vein was thrombosed with growth, it was clear that a few months would see the end. In each case the lumbar incision was carried forwards very freely, and the long axis of the tumour brought out in that of the wound.

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* In a case of attempted nephrectomy (*Amer. Journ. Med. Sci.*, 1882, vol. ii. p. 116), the removal of the organ was rendered impossible, not only by its adhesions to the tissues around, but also, as was proved post mortem, to the colon and pancreas as well.

The danger of ventral hernia is guarded against by using deep sutures, by allowing only gentle movements after the patient gets up, and by the use of a support. In this way herniæ do not result.*

When the kidney has been sufficiently enucleated either out of its capsule, or, together with this, out of the peri-renal fat, the vessels and ureter must be dealt with. The latter should be taken first, as this step, especially if the ureter be enlarged, will facilitate dealing with the vessels.

If the ureter is dilated, and contains foul pus or tubercular matter, the stump should be carefully cleaned out with a sharp spoon and dusted with iodoform, or brought up into the wound with, and retained there by, a suture, for fear of its infecting the wound.

The vessels are then tied in at least two bundles with sufficiently stout carbolized silk,† or chromic gut. This is passed, with an aneurism-needle of sufficient length and suitable curve, through the centre of the bundle, each half of which is tied separately, and finally one of the ligatures is thrown round both halves together. In passing the ligatures, they should be pushed well in towards the spine, so as to leave sufficient room between them and the kidney to prevent all risk of their slipping. If the kidney can be raised out of the wound, passing the ligature is much simplified. If this is impossible, the surgeon may find help by having the lower ribs well pulled up by an assistant, while another keeps the kidney well up by pressure against the abdominal walls, light being also thrown in, in case of need, by a laryngeal mirror, or electric lamp. While the ligatures are being tied, or in dividing the pedicle, no tension should be put upon them.

As soon as the ligatures are secured in position, the pedicle is snipped through at a safe distance from them with blunt-pointed scissors. If the pelvis of the kidney contains foul or tubercular pus, and if there is room, a large pair of Spencer Wells' forceps should be put on the pelvis, and the pedicle cut through between this and the ligatures, so as to prevent escape of septic material. These last are then cut short. If any hæmorrhage now takes place, it is probably due to some vessel * not being included, or an artery having slipped through the knot owing to the parts being stretched at the moment of ligature. In the event of attempts to arrest such hæmorrhage by ligature failing, it must be stopped by applying Spencer Wells' forceps and leaving them *in situ*, or by firm plugging with aseptic gauze dusted with iodoform.

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* It is noteworthy that Prof. Bergmann, of Berlin, whose name is well known in connection with the surgery of the urinary organs, advocates the lumbar operation for the removal of malignant growths of the kidney (*Annals of Surgery*, September 1886, p. 256).

† See foot-note, p. 457.

When a pedicle presents especial difficulties from its shortness, thickness, and the way in which it is overlapped by the kidney, a preliminary ligature should be applied and the kidney cut away well in front of it,† a step which will give access to the vessels and ureter; a double ligature is then applied behind the temporary ligature, which is now removed. Also where the pedicle is very short a portion of kidney may be left to ensure the ligature retaining a safe hold. I was obliged to adopt this course in a case of nephrectomy for calculous pyelitis in which I had removed twelve stones a year before (case No. 6, table, p. 732). A sinus persisted, which became abominably septic. As the stump of the kidney was fetid, I inserted no sutures, and packed the wound with strips of sal alembroth gauze wrung out of turpentine. The patient made a good recovery.

A modification of the above method of leaving a portion of the kidney to form the pedicle may be made use of in cases of kidneys of large size which cannot be brought through the wound. In such cases, the vessels being secured by a temporary ligature or by a Spencer Wells' forceps, the kidney should be cut away in separate portions, thus doing away with the struggle required in

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[*] Mr. Greig Smith (*loc. supra cit.*) gives the following practical hints as to the vessels:—The veins are a good deal larger than the arteries, and overlap them. At the hilum the veins branch quite as much as the arteries—*i.e.*, four or five times—and the subdivision extends farther towards the middle line. It is very frequent for two or more trunks to represent the renal vein, and sometimes surround the artery. The want of uniformity in the renal vessels is against the possibility of ligaturing the artery and vein separately. In many cases this will be found impossible; in none is it necessary. Indeed, the walls of the veins, by acting as a sort of padding, may add to the safety of ligatures, preventing the thread from slipping. Mr. Greig Smith further states that the only deaths as yet recorded from secondary hæmorrhage were in two cases where the vessels were separately tied.

[†] Dr. Lange (New York Surg. Soc., November 22, 1886; *Annals of Surgery*, April 1887) has shown that in a case in which he adopted this course no sloughing took place, as the thick, fleshy part of the pedicle beyond the ligatures was gradually absorbed by the healthy granulations of the wound, which remained aseptic. Dr. Leopold (*Arch. für Gynäk.*, xix. 1), in a case of nephrectomy, tied the pedicle in three, and left a triangular portion of the kidney parenchyma, in order to prevent hæmorrhage. The patient made a good recovery.

bringing out a large kidney and the risks of producing serious shock by pulling on the vessels.*

Another means of treating the pedicle where this is short and matted down, is to cut it through piece by piece, securing each bleeding point with compression-forceps, and tying these off one by one. Or the vessels may be underrun, as in excision of the knee, but on a larger scale, and more *en masse*.

By the above methods the risk of wounding the cava or aorta is avoided. If the amount of kidney left is small, it will no doubt atrophy and give no further trouble, but, if large, some sloughing will probably take place; in such a case iodoform should be dusted on to the stump and free drainage provided.

Another difficulty which may be present now is caused by the kidney having contracted adhesions to the peritonæum and some of its contents. Thus, in a case in which Mr. Adams removed a carcinomatous kidney by lumbar nephrectomy, in separating the adhesions the peritonæal cavity was opened, and the thin free edge of the liver exposed. The wound in the peritonæum was closed with fine catgut sutures, and, in spite of a very troublesome cough, the patient made a good recovery from the operation, dying forty-four days later from malignant deposits in the chest-wall, opposite kidney, and lumbar glands (*Clin. Soc. Trans.*, vol. xv.).

I have three times opened the peritonæum, when using the lumbar incision; to one case, a nephro-lithotomy, I have alluded at p. 720. The other two were cases of growth for which I was removing the kidney. The opening, in each case a small one, was at once covered by an aseptic sponge, and at the close of the operation lightly plugged by strips of sal alembroth gauze, which were renewed at regular intervals. All three cases recovered.

If before or after ligature of the pedicle there is still much difficulty in getting a large kidney through the wound (though if the aids already given are followed—viz., making the first incision into a T, dragging up the ribs, prolonging the horizontal or oblique incision well forward, and separating the peritonæum forwards also—a great increase of space will be given), the surgeon may follow the example of Mr. Barwell (*Trans. Intern. Med. Congr.*, vol. ii. p. 276), who, in a case of nephrectomy calling urgently for completion owing to the hæmorrhage, obtained the necessary room for reaching the pedicle by partially breaking up the gland, and next, having tied the pedicle, cut the gland in two towards the ligature, and then, verifying bloodlessness, severed each half from the pedicle and removed them separately.

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* The question of how far serious shock may be induced by tightening ligatures on parts in such intimate relation with the abdominal sympathetic centres is one of great importance, and needs further investigation. According to Mr. Barker (*Dict. of Surg.*, vol. ii. p. 49), who has taken the trouble to have the pulse watched carefully at this stage of the operation, it is not much affected to the touch, but a sphygmographic tracing taken in one case showed some irregularity during the necessary handling of the kidney, and increased arterial tension when the pedicle was ligatured. From my own experience, any alterations in the pulse are occasional only, and quite inconstant. However the future may decide this matter, it is certain that all manipulations of an organ like the kidney cannot be too carefully carried on, especially towards the close of a difficult nephrectomy.

The pedicle being secured and cut through at a safe distance from the ligatures with blunt-pointed scissors, the surgeon should examine for any bleeding point,* to which the ligatures already in place will act as a guide. When all bleeding is stopped,† a large drainage-tube should be inserted, with one end carried down to the very bottom of the wound and the other cut almost flush with the surface. The wound is then accurately closed with silver-wire and carbolized-silk sutures, some iodoform dusted on, and aseptic dressings applied. If there has been much difficulty in getting out the kidney—and in cases of old inflammation it has to be dug out by touch with very little help from sight—no sutures should be used, the wound tightly plugged with aseptic gauze and boracic acid lint, kept wet with hot boracic acid lotion applied frequently.

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* This may be due to the renal vessels breaking up into a larger number of branches than usual, or to some abnormal vessel. Dr. Lange, of New York (*Annals of Surgery*, October 1885, p. 297), in several bodies found a rather thick venous branch coming from below, behind the pelvis and ureter, and entering into a branch of the renal vein, which took origin abnormally from the renal substance on a level behind the pelvis. Dr. Lange suggests that this vessel may have been a spermatic vein, but was unable to verify this point.

† The question may arise as to what is to be done if hæmorrhage still persist after the kidney is got out, and its pedicle tied. Very few cases will occur in which ligatures cannot be applied to each bleeding point if the wound be well opened up, carefully dried, and light thrown down to the bottom. But if bleeding still goes on, Spencer Wells' forceps must be applied to the bleeding point and left *in situ* for two or three days, during which they will also help to drain the wound. I have used this method twice with good results. If the forceps will not hold on, careful plugging must be resorted to, strips of iodoform or sal alembroth gauze or carbolized sponges (the deepest attached to silk) being systematically packed into the bottom of the wound around a large drainage-tube till the wound is thoroughly filled; an external gauze dressing is then applied, and over this a firm but elastic padding of sal alembroth wool, which is kept *in situ* by firm bandaging. Mr. Clement Lucas (*Trans. Intern. Med. Congr.*, vol. ii. p. 271) nearly lost, from secondary hæmorrhage, a case in which nephrectomy had been successfully performed for suppurating strumous pyelitis. The bleeding came on about the fifteenth day, probably from the ligatures which had been left long being dragged upon. The hæmorrhage again occurred on the sixteenth day, when an attempt was made, after opening up the wound, to slip a ligature along the old ones, and thus to re-tie the pedicle. Hæmorrhage again occurring on the seventeenth day, and the patient being in a most precarious state, the wound was tightly and forcibly plugged with two large sponges steeped in perchloride of iron, and the abdomen bound firmly round with a flannel bandage. Morphia was given subcutaneously. About a week later the removal of the sponges, by cutting away the protruding part, was commenced, and this was completed by the end of another week. No bleeding recurred after the plugging, and the patient made a good recovery.

Dr. Weir, of New York (*Ann. of Surg.*, April 1885, p. 311), during a case of nephrectomy in a young woman the subject of pyo-nephrosis, met with very severe hæmorrhage after ligature of the pedicle. This had apparently been effected with a single ligature. After removing the kidney, a gush of venous blood ensued, which was only partly arrested after repeated seizures with long forci-pressure forceps, but was finally controlled by stuffing the wound full of sponges and turning the patient on her back. The shock was profound, and all the measures to produce reaction were resorted to. Transfusion repeated twice to a total amount of 22 oz., gave rise at first to great improvement, but the patient died ten hours after the operation. The autopsy showed that the hæmorrhage came from a vein of considerable size, 1.5 centimetre above those secured by the ligature and forceps.

B. Nephrectomy by Abdominal Incision through the Peritonæum.

a. By Langenbüch's Incision at the Outer Edge of the Rectus.

b. By an Incision in the Linea Alba.

These two methods may be taken together. The former is the one most usually employed, as it has the following great advantages :—

1. The incision is nearer the vessels and ureter.
2. There is much less general exposure of the peritonæal cavity (Knowsley Thornton).
3. The kidney is reached through the outer or posterior layer of the meso-colon, a step which avoids (*a*) hæmorrhage and (*b*) the risk of sloughing of the colon, as it is the inner or anterior layer—that between the colon and the middle line—which contains most of the vessels to the colon, this layer being especially rich in veins. It is this layer which is divided in the incision through the linea alba.
4. The operation can be rendered largely extra-peritonæal by having the inner edge of the cut meso-colon and that of the parietal peritonæum held in apposition or sutured with catgut.

Both operations give good room for necessary manipulations, both afford an opportunity for examining with the hand the condition of the opposite kidney.* After both the wound can be drained, posteriorly, from the loin, but more easily after Langenbüch's incision.

a. **Langenbüch's Incision.** — The abdominal wall being cleansed, an incision is made, at least 4 inches long at first, commencing just below the ribs, in the line of the linea semilunaris on the side of the disease, the centre of the incision being usually opposite to the umbilicus. The structures, skin, subcutaneous tissue, and the aponeuroses at the outer edge of the rectus being divided down to the transversalis fascia, all hæmorrhage † being carefully arrested, the transversalis fascia and peritonæum are pinched up together, punctured, and slit up on a finger used as a director, the hand is introduced, and the size of the growth and the condition of the opposite kidney investigated. In the case of a large growth, the incision will now be enlarged, and any further hæmorrhage arrested. The growth, if large, is usually now seen in part. Any presenting intestine is turned over to the opposite side, and kept out of the way with a soft flat sponge. The outer or posterior layer of the meso-colon will now probably present itself, pushed forward by the growth, which is often bluish-white in appearance, and covered by large veins. The above-mentioned layer of the meso-colon is next torn through, either in a vertical or transverse direction as will best avoid the vessels exposed. Any bleeding should be at once arrested by Spencer Wells' forceps and ligatures of fine chromic gut. The intestines are next packed away with a flat sponge.

A sufficient opening being next made in the outer layer of the meso-colon, the fingers are introduced to examine into and further separate the connections of the kidney.

During all the necessary manipulations in the case of a growth, the greatest possible gentleness must be used so as not to rupture the capsule. In rapidly growing sarcomata, especially in children, the consistency may be jelly- or glue-like, and thus, if the capsule is opened, portions of the growth may easily be left behind. Again, hæmorrhage may easily follow this accident, and prove most embarrassing.*

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* I cannot but think that this advantage of the incisions through the peritonæum has been made too much of. In Mr. Barker's words (*Dict. of Surg.*, vol. ii. p. 48), "though the hand may reach the kidney opposite to the one it is proposed to excise, its soundness or the reverse cannot be ascertained by mere palpation. Great enlargement, or, on the other hand, great reduction, in size, or complete absence, might be detected; but the organ might be tubercular, or fibroid, or contain a moderate-sized calculus, and yet the hand be unable to detect the condition." I have also referred to this matter, p. 726.

† The amount of this, as will be familiar to all surgeons who have opened the peritonæal cavity by this incision for intestinal obstruction, &c., varies a good deal. In the case of growth large vessels are often present in the peritonæum over the kidney.

The same precautions as to not damaging the capsule should be taken in the case of a kidney full of fluid. Where there is any risk of such fluid or of soft growth being spilt into the peritonæal cavity, sponges (duly counted) should be carefully packed around, or the cut edges of the meso-colon and the parietal peritonæum united.

If the parts about the pedicle are free from adhesions, the vessels may be tied before the kidney is enucleated, which will render this latter step bloodless. Wherever it is possible forceps should be placed on the vessels close to the kidney before they are divided, to save spilling of blood from the kidney, and where this contains pus the same precaution should be taken with the ureter.

The vessels should be tied with the precautions given above (p. 742). All dragging on the pedicle should be scrupulously avoided.

The kidney being removed, the site of the operation is most carefully cleansed and dried. If troublesome oozing has occurred and is at all likely to persist, a large drainage-tube had best be passed out through the loin by pushing a short pair of dressing-forceps from the site of the kidney so that it bulges in the loin, where it is cut down on, and drags through, the tube. Another way of draining is by a Keith's tube in the abdominal incision, sucked out regularly. Both this and lumbar drainage should be employed in bad cases. It has been suggested that the divided edges of the meso-colon may be united with a few points of catgut suture, but this precaution does not seem to be absolutely needful, as they usually fall readily into apposition. If any septic matter is left it will be perilous.

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* Thus it has even happened to Prof. Czerny, whose experience in nephrectomy is almost unrivalled, to be driven to tie the abdominal aorta. The profuse hæmorrhage met with in removing a large growth of the left kidney could only be stopped by pressure on the abdominal aorta. This vessel was accordingly tied. Death took place ten hours later. It was found that the renal artery had been torn through at its entrance into the tumour. The ligature on the aorta had been so placed that, while the blood-supply through the left was cut off, the right vessel was pervious.

Mr. Knowsley Thornton lays stress upon his method of treating the ureter. This tube is taken last in the enucleation of the kidney, "and, before separation, its renal end should be secured by pressure-forceps, then a ligature tied a little way from the forceps, and a sponge placed under it before it is divided. Whenever it is possible, I enucleate it for some distance from the kidney before dividing it, so that its cut end, with the sponge under it, may be at once drawn outside the abdomen; and afterwards fix it in the lower angle, or most convenient part of the abdominal incision, with a cleansed safety-pin. I regard this fixing out of the stump of the ureter as the most important detail in the operation, and in every case in which I have been obliged to cut it off deep in the wound I have had distinct evidence of suppuration and trouble around it." Mr. Thornton considers the objection that this method risks the occurrence of future intestinal obstruction an entirely fanciful one. At the worst, a ureter so treated is only a slight ridge over a small surface of the abdominal wall, quickly disappearing by atrophy. The open end of the ureter must be kept sweet, "for sooner or later it always becomes putrid, the bladder urine also becoming offensive at the same time." Other surgeons who have treated the ureter by ligature and dropping it in, have not met with the results of suppuration and sloughing which Mr. Thornton thinks are very likely to follow on this course. The only after-trouble which I have known the ureter to give is in cases of removal of tubercular kidney. Unless this operation is performed at a very early stage, there must always be a great risk that, owing to the ureter having become involved, the mischief will spread to the bladder.

b. **Nephrectomy by an Incision in the Linea Alba.**—For reasons already given, p. 746, this method is not recommended. that of Langenbüch, already fully described, being preferred.

The incision in the linea alba will not materially differ from that for ovariotomy or abdominal exploration, p. 771, and the same precautions are called for in removing a kidney by this method as in that through the linea semilunaris, of which the chief only need be recapitulated here—viz.:

1. Keeping the intestines well over to the opposite side by carefully applied sponges. 2. By the same means keeping the general peritonæal cavity shut off as much as possible; as pointed out already, this method has the grave objection of more readily causing infection of the peritonæum. 3. Avoiding all large vessels which are met with over the kidney, and securing these carefully with chromic-gut or fine carbolized-silk ligatures before

dividing them. 4. Securing as full access as possible to the kidney pedicle. 5. Dealing as gently as possible with the kidney when distended with fluid, and still more when it is the seat of a soft vascular growth. 6. Separating adhesions, especially any situated posteriorly, with the utmost carefulness. 7. Avoiding all tension on the pedicle. 8. Scrupulously cleansing the site of the wound. 9. If fluids or portions of the growth have escaped into the general peritonæal cavity, ensuring cleansing of this with sponges, or, perhaps better, by irrigation with a warm 2 per cent. solution of boracic acid. 10. Taking care that the cut edges of the peritonæum over the kidney are in exact apposition, either by natural adaptation or by the aid of catgut sutures. 11. Providing sufficient drainage (p. 748), if the operation has been a difficult one and the parts much disturbed, and, always, if septic fluids have escaped into the peritonæal cavity. In this latter case irrigation with boiled water or a 2 per cent. solution of hot boracic acid must be made use of. 12. Conducting the different steps of the operation, especially the earlier ones, with as much expedition as possible, and, in addition, providing against shock by taking those precautions recommended for this purpose in any grave operation, as at p. 739.

C. **Nephrectomy through the Abdominal Wall, but without opening the Peritonæum.**—Having made use of the method in one case five years ago, and being much struck by the room afforded, I may make brief mention of it. The patient was a woman, aged fifty-four, the subject of a movable kidney on the right side, the kidney being also the seat of malignant disease. As the abdominal walls were thin, and as the kidney could easily be made to project in the anterior part of the right lumbar region, I made a longitudinal incision from the anterior superior spine up to the eighth rib. The different layers were cut through, very little hæmorrhage being met with; when the peritonæum was reached this was then stripped up out of the iliac fossa, upwards and inwards, then upwards, off the anterior surface of the kidney until its vessels came in view. No difficulty was experienced in dealing with the pedicle—first the ureter, and then the vessels. The vena cava was seen for about 1½ inch receiving pulsation from the aorta. The patient never rallied thoroughly from the operation,* and sank about twenty-four hours after. Post-mortem the ligatures were found firmly tied; one of those on the renal vein had slightly puckered in the inner surface of the vena cava. A clot the size of the little finger constituted all the bleeding that had taken place. The kidney was, save for one small patch at the lower part, entirely converted into encephaloid carcinoma. Two or three of the aortic glands were enlarged; there were no other secondary deposits.

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* I think that the thinness of the abdominal walls prolonged the operation, owing to my anxiety not to wound the peritonæum. As has been said above, the hæmorrhage was very slight, and I was careful not to pull upon the pedicle.

Choice between Lumbar and Abdominal Nephrectomy.—While it is certain that all kidneys of small or moderately enlarged size can be easily removed by a lumbar incision sufficiently enlarged (p. 739), time alone will show whether I am right in my opinion that before the lumbar method is abandoned a trial should be made of such a free incision as König's (p. 741) when large kidneys have to be attacked. And this leads up to the question of chief importance: How far is the danger really increased by going through the peritonæum to get at the kidney? I am strongly of opinion that, in spite of all the recent improvements in abdominal surgery and their success in preventing *peritonitis*, interference with and handling the contents of the peritonæum, save in the shortest and simplest instances, remains, on the score of *shock*, as grave a thing as ever it was. I am quite aware that, in the hands of a few operators, such as Sir S. Wells, Mr. K. Thornton, and Mr. Tait, removal of kidneys, even in difficult cases, through an abdominal wound involving the peritonæum has given excellent results—results perhaps as good as, or better than, those by the lumbar method. But while allowing this, it cannot, I think, be lost sight of that the kidney is an extra-peritonæal organ, not one, like the uterus and ovary, within the peritonæal cavity. It will assuredly never be brought about that removal of the kidney will pass, like oophorectomy and removal of the uterus or its appendages, into the hands of a few operators specially skilled in abdominal surgery. This being so, and the organ in question being one behind and outside the peritonæum, while each man will decide for himself and according to his special experience and line of work, the majority of surgeons will, I think, prefer to make their attacks from behind whenever this is possible. This question is also dealt with above (p. 726).

LUMBAR NEPHRECTOMY—ADVANTAGES:—1. The peritonæum, save in case of exceptional difficulty, is not opened or contaminated. 2. Efficient drainage is easily provided. 3. The structures interfered with are much less important. 4. As pointed out by Mr. Greig Smith, "in the case of its being unwise, as in abscess, or in tumour affecting the surrounding tissues, to proceed to removal, it is less serious to the patient." If the kidney is firmly matted down, as in the condition given at p. 740, such dense posterior adhesions are most readily dealt with by the lumbar method. 6. The lumbar incision, if converted into a T-shaped one, or prolonged forwards by Konig's method, will give sufficient room for meeting most of the conditions which call for nephrectomy. Thus modified, it will suffice for new growths in their early stages. If these are operated on later, one of the abdominal methods will probably have to be made use of.

LUMBAR NEPHRECTOMY—DISADVANTAGES:—1. It is usually thought that too little room is given by this method for the removal of large kidneys. It has already been shown (p. 741) how extensively this incision can be enlarged. It is doubtful, therefore, if the above objection holds good for any cases, even those of unusually long-chested patients, or those with spinal deformity. 2. In a fat subject the organ may be difficult to reach, even when well pushed up from the front. 3. The pedicle is less easily reached,* and thus, in cases of difficulty, bleeding at a very important stage of the operation is less easily dealt with. 4. If the kidney be very adherent, important structures—*e.g.*, the peritonæum (p. 741) and colon—may be opened into, unless great care is taken. 5. The condition of the opposite kidney cannot be examined into. Possible fallacies here have been pointed out, pp. 726, 747.

NEPHRECTOMY BY ABDOMINAL INCISIONS IN THE LINEA ALBA, OR AT THE EDGE OF THE RECTUS, THE PERITONÆAL CAVITY BEING OPENED—ADVANTAGES:—1. Additional room in case of large kidneys. 2. More easy access to the pedicle. 3. The possibility of examining the condition of the other kidney. It has already been pointed out (pp. 726, 747) that this advantage is probably overrated.

NEPHRECTOMY BY ABDOMINAL INCISIONS THROUGH THE PERITONÆUM—DISADVANTAGES:—1. The peritonæal cavity is opened. 2. The peritonæal cavity may be seriously contaminated if a kidney containing septic matter, or one largely converted into soft growth, is ruptured during the needful manipulations. 3. The intestines may be difficult to deal with, and may, by crowding into the field of operation and the incision in the abdominal wall, prove most embarrassing. 4. The handling and interference with the contents of the peritonæum may cause considerable shock. 5. The vitality of the colon may, by interference with its blood-supply, be endangered. 6. It is more difficult, by this method, to deal with any dense adhesions which may exist behind the kidney. 7. Efficient drainage is less easily provided in cases of any contamination of the peritonæal cavity, or of oozing after the kidney is got out. 8. The after-complication of a ventral hernia is much more probable by this method, though it must be allowed that the free lumbar incision already alluded to may be followed by the same result.

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* This objection and the next can be met by very freely enlarging the wound.

Causes of Death after Nephrectomy.—1. Shock.—This may be induced by hæmorrhage, much traction on the pedicle, and thus, probably, interference with the solar plexus, injury to the colon, or, where the peritonæal cavity is opened, by much disturbance of its contents. 2. Hæmorrhage.—This is especially to to be dreaded where the pedicle is deep and difficult to command; where there are aberrant renal vessels; where these vessels are enlarged and perhaps softened; where, owing to too much tension on the pedicle, a vessel retracts from within its loop of ligature; where the kidney capsule and tissue are broken into. In the intra-peritonæal method there is the additional danger of enlarged veins within the meso-colon. Secondary hæmorrhage has been alluded to above, p. 745. 3. Uræmia and Anuria.—These are only likely to occur when it has been impossible to form a correct estimate of the condition of the opposite kidney, or where, to give a patient a chance, the surgeon operates in what he knows to be a doubtful case. Where there is reason to believe that the suppression of urine may be due to a calculus in the opposite kidney, this should at once be cut down upon in the hope of finding a calculus that can be removed. A brilliant example of what nephrolithotomy may do when such peril sets in at a later date is given by a case of Mr. Lucas's (*Brit. Med. Journ.*, Dec. 19, 1890), in which, four months after a successful removal of one kidney, a calculus was successfully removed from the remaining one on the onset of total suppression. 4. Peritonitis.—This may be simple (*i.e.*, traumatic) or septic. While it is certainly more likely to follow the intra-peritonæal operation, it may occur after that through the loin, especially when much difficulty is met with here, owing to numerous adhesions, or to working in a wound of insufficient size.* 5. Septic Trouble—Cellulitis—

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* That injury to the peritonæum is not always fatal here is shown by a case mentioned (without reference) by Mr. Morris (*loc. supra cit.*, p. 535), in which the pus of a scrofulous pyelitis had contaminated the inner surface of the peritonæum. The patient here rapidly recovered, the operation, which lasted two hours and a half, having been throughout all but bloodless.

Erysipelas—Pyæmia.—These are especially likely when the kidney contains septic matter, when the soft parts are much bruised, or when many fingers enter the wound. Other, rarer, causes of death are—6. Pulmonary embolism. 7. Empyema.—This may be brought about by an extension of septic cellulitis, or by removing during the operation a portion of rib in order to get more room—a step the danger of which cannot be too strongly enforced, p. 713. An anatomical predisposition favouring the passage of inflammation from the kidney to the pleura has been pointed out by Dr. Lange, of New York. This authority on renal surgery found, in one subject, an enormous gap in the diaphragm, the muscle fibres being absent from the ligamentum arcuatum internum as far as the outermost part of the eleventh rib. Between these two points the fibres of the diaphragm communicated in a high arch, bounding an area in which the fatty tissue about the kidney was in direct contact with the pleura. 8. Intestinal Obstruction.—This occurred fatally in one of Mr. Thornton's cases. He thought it was brought about by his suturing the two edges of the peritonæum over the kidney together, and thus producing kinking of the large intestine.

Lumbar Nephrectomies.

No.	By whom sent.	Sex.	Age.	Disease.	Result.
1.	Dr. Moxon.	F.	45	Carcinoma.	Death about thirty hours after, from prolonged shock. This kidney, though greatly enlarged, was got out through a very free lumbar incision by tilting its long axis into that of the wound. I see now that I took up too much time in tying every small vessel as I went along. Two of the glands on the vena cava were carcinomatous.
2.	Mr. E. O. Day.	M.	27	Very long standing pyelitis; drainage.	Recovery. This patient had had cystitis nearly all his life. Eight years before, he had been cut for vesical calculus in Nottingham. He was sent to me in a state of septicæmia, due to a most foul pyelitis. This was drained, but a sinus persisted, and fourteen months later I removed the kidney. This was very small, and so universally and firmly adherent that it had to be literally dug out by the finger. The man had constant hiccough for a fortnight, possibly due to some injury to the phrenic or the diaphragm.
3.	Dr. F. Taylor.	F.	42	Tubercular pyelitis.	Recovery. She is alive 3½ years later, with no irritability of the bladder, and passing no pus.

Lumbar Nephrectomies—(continued).

No.	By whom sent.	Sex.	Age.	Disease.	Result.
4.	Dr. Phillips, Bedford.	M.	—	Tubercular pyelitis.	Recovery, three years ago. The patient completed his terms at Cambridge and took a curacy, where he now is. Though fourteen months after the operation he began to show signs of tubercular mischief in the prostate and vesiculae seminales, Dr. Brogden, of Ipswich, writes (Feb. 1891), "There is practically no bladder or prostate trouble, no pain, no difficulty or undue frequency in micturition, and the urine pretty clear."
5.	Dr. Phillipps, Faversham.	F.	3	Sarcoma.	Recovery from operation. Death two months later. The renal vein was found thrombosed with growth at the operation.
6.	Dr. Perry.	M.	2½	Cystic disease, ? congenital.	Recovery.
7.	Dr. Pitt.	M.	30	Calculous pyelitis.	Recovery. A year before, I had performed nephrolithotomy and removed eight stones. A most fetid sinus persisted, kept up by a phosphatic stone, which I had left behind, in the upper end of the kidney.
8.	Dr. F. Taylor.	F.	18	Tubercular pyelitis.	Recovery. The kidney had been explored and drained six weeks before.
9.	Dr. J. B. Howell, Wandsworth.	F.	23	Pyonephrosis; no cause was made out.	Recovery. The kidney had been explored and drained five months before.

NEPHRORRAPHY.

Indications.—Where the surgeon is able to satisfy himself that a persevering trial of a well-fitting belt has failed; that the pain, whether constant or paroxysmal, is *bonâ fide*;* and that it really cripples and spoils the patient's life. Constipation and dyspepsia will of course have been treated, tight lacing given up, and a trial of massage combined with the use of a belt, or by one of Hawksley's trusses.

Operations for Movable Kidney.—These are:

A. **Nephrorraphy.**

B. **Nephrectomy.**

A. **Operation of Nephrorraphy.**—The kidney is first exposed by the incision† and the steps already fully given (p. 713). The lumbar fascia being opened, the wound is widely dilated by the

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[*] As when it is accompanied by undoubted vomiting. Another condition of movable kidney which calls for operation is when, in stooping, the viscus comes down so far as to be jammed between the ribs and the crista ilii. On the other hand, the operation should be avoided in dyspeptic, neurotic women, especially if approaching the menopause.

[†] In a fat patient a T-shaped incision will be needed.

use of retractors, which gather up the whole thickness of the wound down to the renal capsule, and by an assistant pulling up the ribs if need be. During the rest of the operation another assistant with steady pressure on the right spot forces the kidney into the wound and keeps it there.

The surgeon next examines the kidney, as to whether it is sound, enlarged, &c.

Several questions now arise as to the sutures. (1) What is the best material? (2) What tissues are to be taken up? (3) Are the sutures to be dropped in?—(1) The sutures should be of both carbolized silk and chromic gut if they are going to be dropped in; of carbolized silk only if they are left for subsequent removal. (2) With regard to the tissues taken up, the sutures should certainly include the kidney tissue. In other words, passing them, however numerously, into the peri-renal fat or kidney capsule will not be sufficient. This was well seen in the case of nephrorraphy mentioned at p. 757, in which, after numerous sutures had been thus placed, the kidney still dropped away out of sight as before.

The third question, whether the sutures are to be dropped in or not, is still an open one. Most surgeons, I believe, do so, and this was the method I adopted in five cases of nephrorraphy. The kidney being thoroughly exposed, pushed well up, and its structure, the amount of surrounding fat, and the looseness of capsule having been examined, the surgeon passes from four to six sutures—some of carbolized silk, some of gut—through adjacent parts of the kidney itself and the deeper of the soft parts. The material used is of medium size, so as not to cut out too readily, and the needles are curved and used with a holder. The sutures should be inserted one or two at the lower end, two or three at the outer and one or two at the inner border. They should dip well into the kidney tissue on the one hand, and pass through the lumbar fascia and muscles on the other. When sufficient are inserted and knotted so that the kidney no longer falls away when the supporting hand of an assistant is removed, a little iodoform is dusted in, the sutures are cut short, and the wound over them closed with silk and wire sutures.

Very little bleeding follows the simple punctures of the kidney substance implied in the above method.

The objection to this plan is that if only chromic-gut sutures are made use of, they may soften and come away too soon.* If silk are used, even when care has been taken with the preparation, they may come away with vexatious repetitions through a long persistent sinus (p. 458).

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* Dr. Newman (*Glasg. Med. Journ.*, 1883) has observed, as might be expected,

Another method is one used by Mr. Morris,[*] and consists in passing sutures of silk and chromic gut through the entire thickness of one lip of the wound, then through the capsule and cortex of the kidney, and finally through the other lip of the wound. When these sutures are tied, the wound is closed and the kidney fixed at the same time. I have employed this method in one case, using some buried sutures also. The result was satisfactory. In one of Mr. Morris's cases a single stout catgut suture passed as above seems to have been successful in fixing the kidney. In the other case, where silk and catgut sutures were thus passed, the former was not removed till the thirteenth day. I have used Mr. Morris's method in three cases. As in these antiseptic operations no suppuration is present, and the union, though quickly formed, is of a weakly kind, it is quite impossible that the kidney should be permanently fixed by the time that it is needful to remove the sutures. I find chromic gut softens too soon, and both it and silk, if used in this way to bring up a kidney into a deep wound with much fat in its edges, tend to cut. I therefore prefer to use sutures cut short and dropped in. There is nothing better for these than well-prepared kangaroo tail (Gould, *Lancet*, 1888, vol. ii. p. 674).

Three cases of very movable kidney under my care have been complicated with grave organic disease. In one (case 1, table, p. 754) carcinoma was present; in another, a large hydronephrosis. In a third (case 9) the kidney proved to be not only movable, but the seat of pyelitis as well. The woman, æt. 44, was a patient of Dr. F. Taylor's; other treatment, including a well-fitting belt, having failed to give relief, I was asked to perform nephrorraphy. The loin being a thin one, and the kidney easily brought up to the surface, the operation was very easy. I began by putting in eight or ten gut sutures between the peri-renal tissues and the edges of the wound. These had no effect whatever, as, when my dresser, Mr. A. E. Poolman, removed the very efficient support which he was applying through the abdominal walls, the kidney receded completely out of sight. Three carbolized silk sutures passed between the kidney itself (the needle being dipped well into its substance) and the edges of the incision, and cut short, kept the kidney,

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that the part of the catgut sutures which lies in the vascular kidney tissue itself softens with especial quickness.

[*] *Annals of Surgery*, April 1887.

without any other support, quite up in the wound; in fact, the patient being thin, the organ now lay almost subcutaneous. The wound was so completely closed by the viscus that no drainage-tube could be inserted. Primary union took place throughout, and the wound was healed in ten days. About two months later, the pain being re-established, further examination proved that the urine, which had before been found normal, now contained pus. Three months after the nephrorraphy I explored the wound. This was rendered a little difficult by the incision passing through scar tissue. The silk sutures fixing the kidney were found *in situ*. The kidney itself now showed two cystic expansions, both small—one about the size of a hen's egg, the other that of a walnut—one at the upper and one at the lower extremity. Fine trocar punctures removed pus. The kidney, not being much enlarged, came out easily through the ordinary lumbar incision, and the patient made a good recovery.*

The minutely careful antiseptic precautions of the present day, with the slight degree of inflammation and the almost entire absence of suppuration in our wounds, do not favour firm, fixing union of the kidney. Mr. Greig Smith (*Abdominal Surgery*, p. 513) advises, in every case of doubt as to the exact nature of the mobility—whether the kidney be movable inside its capsule or in the surrounding fat—to expose the free border of the kidney and set up aseptic inflammation, which may result in plastic adhesion, by freely moving the finger over the renal surface.

B. **Nephrectomy for Movable Kidney.**—This operation will be very rarely required. It should be reserved for cases—(i.) where the kidney is not only movable, but diseased, as above; (ii.) where nephrorraphy has failed to give relief, and the suffering is *bonâ fide*; (iii.) where a misplaced, movable kidney cannot be pushed back into the loin.†

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* Though the kidney had been carefully inspected at the previous operation by Dr. Taylor and myself, though I had had opportunities of handling it, and though the needle-punctures gave vent only to blood, I think the suppuration must have been present at the time of the nephrorraphy. This case and others recorded show that movable kidneys do sometimes have a basis of organic disease.

I would allude to another case of nephrorraphy to emphasize the remarks made in the foot-note at p. 458. Here, in inserting six sutures of carbolized silk between the lower extremity and borders of the kidney and the edges of the cut lumbar fascia, I made use of the closely plaited silk known as Turner's. This can so resist all cell changes, &c., that for eleven months the sinuses persisted, discharging these silk sutures absolutely unchanged. I finally had to open up the sinus and remove the last stitch. It was absolutely unaltered.

† Morris, *Surg. Dis. of the Kidney*, p. 42.

CHAPTER V.

OPERATIONS ON THE INTESTINES.

ACUTE* INTESTINAL OBSTRUCTION.—ENTEROTOMY. —FORMATION OF ARTIFICIAL ANUS IN INTESTINAL OBSTRUCTION.—SUPPURATIVE PERITONITIS.—TYPHLITIS AND APPENDICITIS.—CLOSURE OF ARTIFICIAL ANUS.—ENTERECTOMY. —COLECTOMY.

ACUTE INTESTINAL OBSTRUCTION.

THE following practical, though very brief, remarks on the chief varieties may be helpful at the time of operation :—

A. *Strangulation by Bands and through Apertures.*†

1. Adventitious peritonæal bands. Perhaps there has been a history of peritonitis, starting possibly from the cæcum, the uterus and appendages, or a mesenteric gland. These bands are usually attached by one end to the mesentery. 2. Omental bands. Here some part of the lower end of the omentum has become adherent to the brim of the pelvis, a hernial sac, the uterine appendages, or the cæcum. 3. Meckel's diverticulum.‡ This is usually met with in young subjects. Tubular or cord-like, it will be found attached at one end to the ileum, within 3 feet of the cæcum, at the other near the umbilicus, or to the mesentery or intestine. Under this arch small intestine is very liable to slip. In other cases one end is free, and ensnares or knots up a loop of intestine. 4. Some normal structure abnormally attached. Such are a

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* Chronic intestinal obstruction has been alluded to under the head of Colotomy, p. 676.

† Mr. Treves (*Intest. Obstruct.*, p. 13; *Dict. of Surg.*, vol. ii. p. 802) thus groups these together from the similarity of their obstruction and their close resemblance to strangulated hernia.

‡ A most interesting and fully reported case successfully treated by laparotomy was published in the *Lancet*, March 9, 1889, by my old friend R. J. Pye-Smith, of Sheffield. Two others successfully treated in the same way by Mr. Clutton (*Clin. Soc. Trans.*, vol. xvii. p. 186) and Mr. McGill (*Brit. Med. Journ.*, January 14, 1888) will well repay reference.

Fallopian tube or the vermiform appendix. 5. Some aperture or slit. This may be congenital or traumatic, and situated in the omentum, mesentery, &c.

In all the above, the lower part of the ileum is the portion usually strangulated.

B. *Volvulus.*—The intestine here is usually either twisted on its mesenteric axis, or bent at an angle. The former is the more acute condition, owing to the strangulation of vessels. It is most commonly met with in the sigmoid flexure, when this has a long mesocolon, especially in adults who have been subject to constipation (Treves).

The distension may be enormous, the sigmoid appearing to occupy all the abdomen. Ulceration leading to fatal peritonitis may set in either in this intestine or in the colon or cæcum (p. 692).

C. *Strictures.*—These have been considered, with chronic obstruction, under the head of Colotomy (p. 676).

D. *Foreign Bodies* (e.g., *Gall-stones*) *becoming Impacted.*—The patients here are usually over forty-five: often stout women of sedentary habits, with history of past colic, &c. The stone is usually a large one which has ulcerated into the duodenum. The urgency of the symptoms will vary, of course, with the size of the stone,* the completeness of the impaction, and the site. This is usually in the lower ileum.

E. *Intussusception.*—From its frequency, especially in young life, its fatality in infants, the fact that its treatment is more satisfactory because its diagnosis is easier than other forms of obstruction, this form of intestinal obstruction deserves careful notice. Of the varieties—the enteric, the colic, the ileo-colic, and the ileo-cæcal—the frequency of the last is well known. It is to this variety, especially in children, that the following remarks mainly apply.

The frequency with which intussusception is still left undiagnosed appears to be due to a failure to examine the rectum, or to a misinterpretation of what is found there in acute cases (an intussusception being called a prolapsus), and, in less acute cases, to there sometimes being very few symptoms at all.

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* Sometimes no such history is attainable. Thus, in a very interesting case of Mr. Bryant's (*Clin. Soc. Trans.*, vol. xii. p. 106), in which he removed a gall-stone from the ileum which had caused complete obstruction for three days, the patient is stated to have been perfectly healthy up to the time of the attack save for occasional indigestion. At the post-mortem examination an old communication was found between the gall-bladder and the duodenum.

With regard to treatment, it cannot be too strongly insisted upon that, in this form of obstruction, there is no excuse for delaying active steps. If intussusception is suspected, the trial of belladonna or opium, warmth aided by friction, should be a brief one; and if a tumour is to be felt, especially if per rectum as well as through the abdomen, it should be briefer still. No time should be lost in trying inflation or injection. I prefer to begin with the former. A little ether being given, the lower limbs being somewhat raised, the nozzle of a Lund's inflator, or a full-sized catheter, or a rectal tube, attached by tubing to a bellows and well coated with vaseline, is carefully passed into the bowel. The nates being securely pressed round the tube, air is steadily pumped into the colon, while the surgeon keeps one hand on the abdomen, not only to prevent over-distension, but also to watch for any receding of the tumour towards the cæcal region.

With regard to the force used, Dr. Goodhart (*loc. supra cit.*, p. 125) remarks: "Replacement of the bowel can usually only be effected by considerable distension of the whole colon, and distension of the colon sometimes requires a good deal of rather forcible pumping to complete it." This is especially the case with regard to the last few ounces of air sent in. Dr. Taylor's* advice here will minimize the risk of rupture of the bowel: "The risk can be reduced to a minimum by injecting, carefully and slowly, successive small quantities, and by gently kneading the abdomen so as to facilitate the passage of air upwards, and thus prevent the sudden over-distension of short lengths of the colon."†

Inflation failing, if the condition of the patient admit of it, more powerful means may be made use of by connecting the rectal tube with an improvised water-cistern placed high above the bed, a more equable and forcible distension being thus obtained.‡

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* *Clin. Soc. Trans.*, vol. xvi. p. 71. Dr. Taylor thinks that two kinds of cases are unsuited for inflation: One, in which the intussusception actually projects from the anus, as this form shows enormous forcing power on the part of the intestine, while, after replacement by the fingers, the amount of air that can be brought to bear is necessarily small. Dr. Taylor's other group unsuited for inflation is where no tumour can be felt and the diagnosis depends solely on symptoms. He points out that here it is impossible to judge of the effects of inflation.

† The value of this was shown decisively in the case of an infant recently inflated by Dr. Perry and myself. Pumping in of air had at first little effect; while it was continued, and my colleague manipulated the parts, first, one gently snapping sound, and a little later a louder one, as of unfolding intestine, were heard, and the swelling was found to have disappeared. Though the infant passed a natural motion, the intussusception recurred.

‡ Goodhart (*loc. supra cit.*). It is pointed out that this method entails a greater risk of rupture of the bowel, but that the end justifies the means (con-

These methods failing, while the child is still under an anæsthetic, preparations should be made for operation. Before describing this, it may be useful to point out, as far as this is possible, in what cases this is likely to be called for and how often it is likely to be successful. The following will help towards an answer to the above questions:—

α. The duration of the case. In the majority of cases, especially in children, the tendency of the condition is to strangulation, and not incarceration, and while the rapidity of the strangulation varies a good deal, the chances of inflation or injection are small, unless in recent cases.

β. If the above is correct, it is obviously of much importance to decide whether the bowel is strangulated or incarcerated. Mr. Hutchinson (*Med. Chir. Trans.*, vol. lvii. p. 31) points out that the severity of the symptoms will be helpful here—viz., the urgency of the vomiting, the degree of the constipation, the character of any stools passed,* &c., any indications of collapse, and, above all, as utterly incompatible with gangrene, advance of the tumour further on in the large intestine.†

γ. The condition of the patient as to collapse, &c.

δ. Age. In infants under a year, unless reduction is early tried and is quickly successful, the prognosis is very desperate, whether an operation is performed or no. Mr. Hutchinson thinks that this fact may be held to justify very early resort to operation.

The same surgeon thinks that while, on the one hand, the cases best suited for operation are those which have persisted for some considerable time, and in which the intestine is only incarcerated, on the other hand, "cases in which the symptoms are very severe, or the stage generally advanced, it may be wiser to decline the operation and to trust to opiates."

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sidering the great danger of these cases), provided that the requisite distension cannot be procured without.

* Dr. Fagge and Mr. Howse (*Med. Chir. Trans.*, vol. lix. p. 90) pointed out that blood in the stools of these cases does not necessarily mean strangulation and threatening gangrene. Thus it may be present, in chronic cases, from the first, as in Mr. Hutchinson's, where blood-stained mucus was passed for a month, at the end of which time Mr. Hutchinson was still able to reduce the intussusception by a successful operation. In other chronic cases no blood may be passed for a long time; it may then appear with other symptoms and rapidly destroy life, though no gangrene is present. Lastly, in some of the cases in which the bowel has sloughed away, no blood has been, at any time, passed.

† Dr. Goodhart (*loc. supra cit.*, p. 122) points out that, while this symptom means that no sloughing and no firm adhesions are present, it cannot be inferred, owing to the œdema and inflammation which are already present, that because the tumour thus alters its position, therefore it can be reduced.

Operation.—The child being still under the influence of the ether which has been given for the attempted reduction, the parts being cleansed and any urine drawn off, an incision is made, usually in the middle line,* sufficient to admit of the easy introduction of two or three fingers. Before opening the peritonæal cavity the bleeding should be entirely arrested. The intussuscepted mass is now found, and, if possible, hooked out into the wound. If this be feasible, careful persevering attempts are made at reduction by a continued action of gently squeezing the lower end of the mass so as to push out the ensheathed mass, while at the same time the unsheathing layer is drawn off.

Dr. Senn's advice (*loc. infra cit.*, p. 128) should be always acted upon: "The œdema and inflammatory swelling should be removed before any attempts at reduction are made. This can be readily accomplished by steady and uninterrupted manual compression of the invaginated portion."

If the parts are not sufficiently mobile to allow of thus bringing up the intussusception, the wound must be enlarged sufficiently to introduce two fingers of each hand. The following remarks of Mr. Hutchinson† show how great may be the difficulties and the best means of meeting them. Having failed to hook up the mass or to reduce it *in situ*, he was "obliged to enlarge the wound freely above the umbilicus, and to allow the intestines, much distended with gas, to escape. It was only when the abdomen was almost empty that I could bring the neck into view in the wound, and then made repeated attempts to draw the bowel out, but without success. That there were no adhesions was proved by the fact that an inch or two could be easily drawn out, the impediment was clearly due to the ensheathing bowel being thrown into folds by traction, and thus constituting a series of strictures which gripped its contents. In this dilemma, and when almost in despair as to whether I should accomplish the reduction, it occurred to me to seek the lower end of the invaginated part, and try to hold the ensheathing part to prevent its being drawn into folds. . . . . The attempt to hold the ensheathing layer straight at once revealed the true mode of reduction, for by pulling this downwards instead of trying to pull the involved part upwards, I accomplished the replacement with the greatest ease."‡ Mr. Hutchinson thinks that, in future, the lower ends should be always first caught, and that reduction by squeezing this or pulling the sheath down rather than dragging the contained tube out might be accomplished without bringing the parts into view. If this failed it would be more easy, in intussusception into the descending colon, to bring the lower part into the wound than the upper one. This opinion of Mr. Hutchinson's has been confirmed by the following cases:—Mr. Howse's, a successful operation on an adult (*Med. Chir. Trans.*, vol. lix. p. 88); Mr. H. Marsh's case, also successful (*ibid.*, p. 81), in an infant seven months old; and in another case of the same surgeon's (*St. Barth. Hosp. Reports*, vol. xii. p. 98). Here, as by no justifiable force could any part be drawn out, the contained bowel was pushed or backed out by gentle squeezing movements between the finger and thumb, these being shifted gradually upwards along the gut till the cæcum appeared.

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* Or in one linea semilunaris, usually the left.

† *Med. Chir. Trans.*, vol. lix. p. 100. The patient in this, Mr. Hutchinson's second case, was only six months old, and died of peritonitis.

‡ To meet the difficulty of reducing the small intestines, Mr. Hutchinson

Whichever method is found to answer best must be persevered with till every atom of the mass is reduced, this being often known by the appearance of the vermiform appendix.

Every care should be taken throughout the operation to prevent chilling, both of the child's body and limbs, and especially of any intestine which may have to be withdrawn, p. 772. The precautions given a little later, as to instruments, irrigation of wound, and of peritonæal cavity if needful, and closure of the wound, should be adopted.

As in all abdominal sections, this operation should be concluded as speedily as may be.

Where the intussusception cannot be reduced, all attempts either at traction or kneading only producing tears in the peritonæal coat, the following courses are open:—(1) If there be much collapse, to close the wound and do no more; (2) resection and suture of the cut ends (this is only allowable when the intussusception is small in amount); (3) resection and formation of an artificial anus;* (4) formation of an artificial anus without resection; (5) making an artificial communication between parts of the bowel above and below the intussusception.

Dr. A. Senn (*Surg. Treat. of Intest. Obstruct.*, p. 129) has thus treated artificially induced intussusception in animals with entire success. He uses decalcified bone discs (*vide infra*, Fig. 119,

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punctured them at two or three spots to let out flatus. Unfortunately, fæces escaped from one, which required closing.

[*] Dr. Senn quotes a case of Wassiljew's (*Centr. f. Chir.*, 1888, No. 12), in which an operation was performed to close the artificial anus six weeks later. It was ultimately successful.

p. 776), and states his conviction that this method will prove useful in practice. The patient's condition after an attempted reduction of a difficult intussusception will usually be so grave as not to admit of any further operative steps which are at all prolonged. Resection should only be practised when gangrene is present. Dr. Senn points out that in the ileo-cæcal or common variety it will be very difficult to restore the continuity of the canal by circular enterorraphy, owing to the difference of the lumen in the two parts of the bowel. He accordingly advises either lateral implantation of the ileum into a slit in the colon, after the end of this has been closed, or restoring the canal by intestinal anastomosis, by aid of perforated decalcified bone discs, both ends being first closed and placed in lateral apposition. This method requires much less time than a circular enterorraphy, while it secures better conditions for definite healing.

The chief points in the after-treatment consist in a wise use of warmth, milk and brandy, and laudanum.

EXPLORATION OF ABDOMEN IN ACUTE INTESTINAL OBSTRUCTION.

Question of Operation in these Cases.

While it is impossible, owing to the obscurity of the diagnosis, to lay down any definite rules, I trust that the following remarks may be found of some help :—

1. *Difficulty of Diagnosis.*—This is a matter of twofold importance. (*a*) Is the case one of acute obstruction at all, or is it one of peritonitis, or peri-typhlitis? (*β*) If the symptoms are due to some mechanical cause brought about by acute obstruction in the form of a band, internal hernia, or volvulus, which of these is it; and is it one admitting of remedial interference?

It seems to me that this is one of those instances in which the advances made in operative surgery have outstripped those of diagnosis. From the hidden nature of the lesion this must be so, but as long as the diagnosis of these cases remains so obscure, so long shall we be uncertain and hesitating in our treatment.

2. *What is the Proportion of Natural Recoveries without Operation in Cases of Acute Intestinal Obstruction?*—On this point there are two quite different camps of opinion, and neither, it seems to me, can really point to any better success than the other. On the one hand, Mr. Hutchinson, a man of vast experience and one of the acutest observers the profession has ever known, has lately (*Archives of Surgery*, p. 3), re-expressed his opinion "that the

evidence is in favour of the belief that these forms of strangulation are often in early stages effectually relieved without operation; that, in fact, cases of recovery without operation, after very acute symptoms, are not uncommon."*

On the other hand, we have surgeons—*e.g.*, Mr. Treves and Mr. Greig Smith†—condemning expectant treatment, and strongly urging an early resort to abdominal section.

While I should differ from Mr. Hutchinson as to recovery in acute intestinal obstruction being not uncommon, while I should agree with those surgeons who hold that such recovery is quite exceptional, I cannot think that they have proved their case that the indication is clear for early operation. Every one who has even a limited acquaintance with surgical literature must have noticed the number of operations that have been performed for acute obstruction in late years. Yet how few have been successful. And can any one doubt that the published cases bear a small proportion to the whole number submitted in late years to operation? I am aware that the answer is that the surgeon is not called in till too late. Not being without experience in this matter, I fear that this answer will not cover all the cases. It is at least a striking fact that those who are rightly considered authorities on this subject, men who have had the opportunities of urging early operations, have not been able to publish cases which should make us hope at least that the tide is on the turn. And this leads me up to my next point.

3. *A certain proportion of these cases, probably a large one, are hopeless, if not from the first, so early in the case as to render any operation futile.*—I say this, not as holding pessimist views on this question, but from a deep conviction from numerous cases that I have seen, and several that I have operated upon. I refer not of course to cases of intussusception, or simple bands,‡ but to

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* If my readers will refer to Mr. Hutchinson's speech at Bath twelve years ago (*Brit. Med. Journ.*, 1878, vol. ii. p. 305), they will find his opinion still more strongly expressed and his aversion to operation still more decided.

† Mr. Treves writes: "With regard to the curative treatment, the only measure is laparotomy. In the first five at least of the above-mentioned conditions spontaneous cure, while not absolutely impossible, is yet so exceedingly improbable that it cannot be considered while discussing the treatment of the case." The following are Mr. Greig Smith's words:—"To cases of acute obstruction there is practically but one termination—death. . . . . Certainly 95 per cent. of all such cases die. Here, then, the indication is clear enough—as clear as the indication to tie a bleeding carotid—operation."

‡ Cases of Meckel's diverticulum will always be most favourable ones for operation, from the greater simplicity of the lesion, and the usually young and healthy patient. Three successful cases are mentioned at p. 759.

those of volvuli with severity of twist, complicated snaring or knitting up by bands, and matting of coils by old inflammation started in mesenteric glands. To name one more condition ; how often has the surgeon in operating found the obstruction, set free some imprisoned loop, and then found all his trouble made of naught, this first loop being only lately drawn under the constriction, by another coil which he finds deep in the pelvis, evidently the source of the trouble, and for some time past recovery ? I have found every one of these at operations.

In writing this I would not dissuade from early operations, but I cannot agree with the tendency which has set in at the present time to write and say that the only reason these operations are not successful is because they are performed too late. Even if it is possible to operate always early, a considerable proportion will, unless I am mistaken, continue to baffle us.

4. The *comparisons* which have been made *between an operation in these cases of acute obstruction and those for herniæ, between abdominal section here and in ovariotomy*, is most misleading and dangerous. Thus, a surgeon for whom I have the highest respect, Mr. Teale, writes thus : " As to the impunity with which the peritonæal cavity may be opened, I need hardly remind you how constantly this is proved in operations for hernia. We think nothing of pulling out and handling coils of intestine, and we rarely look for danger unless the bowels have been damaged by too long continued strangulation." I am afraid the two cases are not comparable. A carefully conducted herniotomy, even in a huge inguinal hernia with omentum, small intestine, and cæcum down, can be made, with care, a practically extra-peritonæal operation. It would be easy, moreover, to show that in the shock, in the time taken, in the condition of the structures met with, the two operations are scarcely comparable.

So too with the comparison with ovariotomy, the same surgeon writes : " Again, in ovariotomy, what are the dangers there ? Mainly from the fluids poured out from adhesions and divided vessels, dangers which, as a rule, are absent in gastrotomy." I cannot think that, save in a few cases, these operations will ever run on parallel lines. Ovariotomy is an operation in which diagnosis has much more kept pace with operative treatment. In ovarian tumours it is the difficult cases, the delayed operation, which will more and more become the exception; in acute intestinal obstruction I fear the conditions are such that the above will remain the rule.*

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* It would not be difficult to show that the condition of the patient before

5. *The Failure of Previous Treatment.*—From the very first the treatment should be limited to warmth, nutrient enemata,* ice to suck, and only sufficient morphia (subcutaneously) to secure sleep enough to support the strength and to allay pain, not to mask important symptoms, and give a fallacious appearance of improvement. Kussmaul's plan of removing gas and fluids from the stomach and upper intestine by siphon action of a soft tube may be tried in cases where vomiting and distension are urgent. If it arrest these it will at least retard (α) the exhaustion of the patient, (β) those changes in the intestine which impair its action and favour peritonitis. Irrigation with warm water and some harmless antiseptic, as boracic acid or sodium salicylate, may be also employed. The tube should be passed every four hours, or oftener if needful. It is always well to do so before an anæsthetic is given to patients with obstruction and vomiting. This may prevent the anæsthetic causing sickness, which may easily prove fatal from fluid entering the trachea. How long should this treatment be persisted in? Each case must be decided by itself, but, in the great majority of cases of acute obstruction, the operation, to be successful, must be performed within forty-eight hours.

Mr. Hutchinson (*loc. supra cit.*) for over thirty years has advocated *abdominal taxis*, with the object of causing very considerable movement of the abdominal contents, and thus effecting replacement, if the taxis be adopted before swelling has occurred, or adhesions formed. In support of his advocacy Mr. Hutchinson appeals "to the well-known facts as to the looseness of many bands, the large size of many apertures, the slight character of many twists, the smallness of the strangulated loop in many cases."

"The first point in abdominal taxis is the full use of an anæs-

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ovariotomy is very different from one submitted to abdominal section for obstruction. And with regard to the operation itself, in the one case the surgeon knows what to expect; in the other he is too often utterly in the dark.

* I do not recommend large enemata, either for diagnosis or treatment. I look on them as powerless in the latter unless such large quantities are introduced as to be dangerous. For purposes of diagnosis there is one condition in which they may help, and that is stricture of the sigmoid flexure. Two fallacies which must always be remembered are given at p. 683. If the surgeon desire to use a large enema to decide the position of a stricture believed to be in the lower part of the colon, he should use warm milk, and introduce it, not by a long tube, but by a short one, tubing and funnel, with the patient in the knee-chest position. Hegar, who advocates this (*Deuts. Klin.*, 1873, Hft. 8), states that elevation of the funnel to the height of a foot will usually suffice to send the fluid as far as the cæcum.

thetic, so as to obliterate all muscular resistance. Next (the bowels and bladder being supposed to be empty) the surgeon will forcibly and repeatedly kneed the abdomen, pressing its contents vigorously upwards, downwards, and from side to side. The patient is now to be turned on his abdomen, and in this position to be held up by four strong men, and shaken backwards and forwards. This done, the trunk is to be held feet uppermost, and shaking again practised directly, upwards and downwards. Whilst in this inverted position, copious enemata are to be given. The whole proceedings are to be carried out in a *bonâ fide* and energetic manner. It is not to be the name of taxis, but the reality, and great patience and perseverance are to be exercised.* The inversion of the body, and succussion in this position, is on no account to be omitted, for it is possibly the most important of all. I do not think I ever spend less than half or three-quarters of an hour in the procedure."

Later on (p. 135) Mr. Hutchinson writes that he "fully recognizes the propriety of exploratory laparotomy in cases in which the symptoms have persisted after one or more persevering attempts at taxis under anæsthetics, although even here I may confess to serious misgiving that operations will not, on the whole, tend to reduce the mortality."

It cannot be too strongly insisted on that this method of abdominal taxis can only be safely used in the early stage of acute cases, and that evidence of peritonitis, a condition notoriously difficult of diagnosis, absolutely contra-indicates abdominal taxis.

Several cases in which Mr. Hutchinson used this method successfully will be found in vol. i. of his *Archives of Surgery*.

6. *The Condition of the Patient.*—If an operation is to be performed the pulse should be fair, the temperature not falling, the abdomen not much distended, and with sufficient peristalsis to make it probable that there is little or no peritonitis. On the other hand, when the patient has been for many days treated by drugs the operation should not be performed, as it too often is, on the mere chance of relief. I may quote here from a previous paper of mine:† "Those who wait, as I venture to say too many have waited, till the abdomen is generally and enormously tympanitic, till the temperature is falling before the inevitable end, till

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* "It is to be admitted, respecting abdominal taxis, that it is a troublesome and somewhat undignified procedure, affording no scope for the surgical skill which a laparotomy requires."

† *Brit. Med. Journ.*, September 27, 1879: "Case of Acute Intestinal Obstruction by Bands; Operation; Death Ten Days after."

the pulse is running down and the patient in a condition of irrecoverable collapse, those who wait till all or any of these things are present had far best not operate at all. It is only too easy to foretell the operation that follows. The abdominal cavity is opened readily enough, and then the difficulties begin; coils of enormously distended intestine at once crowd up at the mouth of the incision, the operator has the greatest difficulty in finding a contracted portion, and so of tracing out the point of obstruction; perhaps, during his endeavour to do so, a fæcal odour becomes apparent, showing that the intestine has already given way; or, granting that the seat of mischief is found, and the cause removed, in spite of all his endeavours the surgeon finds himself with several coils outside the abdomen, and is at his wit's end to get them in again; perhaps he punctures them, but owing to the paralysis of the muscular and the infiltration of the serous coat, which has by this time taken place, the puncture in the mucous coat is not closed, or does not slip away from directly beneath the opening in the serous; as the intestine is returned, liquid fæces are seen escaping, any attempts to suture this point only makes matters worse, and the patient sinks quickly after his removal from the table."

Operation.—Before this the surgeon should see that the following are in readiness, the instruments being in carbolic acid (1 in 40)—scalpels, probe-pointed bistoury, a steel director, six pairs of Spencer Wells' forceps, scissors, two pairs of dissecting forceps, large retractors, ligatures and fine sutures of carbolized silk and chromic gut, reliable sponges, known to be clean beforehand, and soaking for two hours in carbolic acid (1 in 60), two of these should be flat, two or three quarts of a 2 per cent. solution of boracic acid, kept hot, for irrigation of the peritonæal cavity if needful, some new towels cut in half and soaked in warm carbolic solution (1 in 60), very fine needles, a Keith's drainage-tube, and iodoform. The temperature of the room should be 80°. The precautions given (p. 830) against shock must now be taken.

The bladder is first emptied, and the abdominal wall shaved and cleansed (p. 667). A water-bed should be filled with *hot* water. The blankets on which the patient lies are protected with warmed macintoshes, and on one of these is spread a towel, wrung out of carbolic acid solution, on which the instruments are placed. A porringer of hyd. perchlor. solution (1 in 1000) should be at hand for the surgeon and his assistants to dip their hands in. The parts being relaxed, and ether or the A.C.E. mixture given, the surgeon begins with a central incision below the umbilicus,* going quickly down to the peritonæum, but arrests all hæmorrhage before this is opened. If the linea alba is not hit off exactly, and is not quickly found, any muscular fibres are torn straight through with a steel director, and the transversalis fascia and peritonæum thus quickly reached.

The peritonæum should always be well lifted up before it is opened, especially if there is distended bowel beneath. The opening is then enlarged for about 2 inches with a blunt-pointed bistoury or scissors, two fingers with the palmar aspect turned upwards serving now as the best director. Up to this time irrigation† with hot hyd. perchlor. solution (1 in 1000) has been made use of, but is now stopped.

Mr. Greig Smith advises, where the peritonæum is thin, to pinch it up between the finger and thumb, and roll it about to see that no bowel is included.‡

The surgeon should now decide which mode of exploration he will make use of. The following is as useful as any. If the parts are not much distended, three possible sites of strangulation should be first looked to. The cæcum, which will give twofold evidence, first, its distension or emptiness telling whether the obstruction is above or below it; and secondly, the state of its appendix, whether normal or free, whether empty or containing some concretion. Next, the internal inguinal, the femoral, and obturator rings are explored, to make sure that no tiny hernia exists, imperceptible from the outside. The fingers are next swept upwards towards the umbilicus, in the hope of finding one of the diverticular bands mentioned at p. 759. If, up to this, the search has been fruitless, the brim of the pelvis is next examined, as bands of omenta are often fixed hereabouts, and also because, in women, local peritonitis, originating in the uterus or its appendages, is, not infrequently, the source of the obstruction.

If the above search with two or three fingers or the hand fail, and it often will when distension is present, embarrassing the fingers in their movements, and obscuring the relation of parts, one or two of the loops which lie nearest to the wound should be carefully scrutinized.* These should be followed in the direction of increasing congestion and distension, thus leading to the obstruction.

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* In those rare cases where the obstruction can be localized to one or other side of the abdomen, a lateral incision may be made use of, either over the swelling if any be present, or in the linea semilunaris.

† Unless the peritonæal cavity requires washing out, the surgeon need not trouble about further irrigation, if he is scrupulously careful that *everything* used is aseptic.

‡ If much fluid is present, it now often shows itself through the peritonæum.

If this prove fruitless, the most distended part of the intestine should be drawn out under a new piece of towelling, just wrung out of hot carbolic acid (1 in 60) or boracic acid (2 per cent.). When there is not much distension, the plan adopted by Mr. Cripps (*Clin. Soc. Trans.*, vol. xi. p. 225) is the simplest—*i.e.*, to draw out some inches of intestine at a time, bit by bit, from the upper part of the wound, passing it in again into the belly through the lower part, in such a way that at no time are more than 5 or 6 inches of intestine exposed. After drawing out and replacing some feet of intestine in this way, it is probable that, owing to the increasing congestion or resistance, the surgeon will reach the obstruction.†

If an assistant holds the coil from which the surgeon starts in the lower angle of the wound under a hot sponge, it may save the surgeon going over the ground a second time. If a search for ten minutes has failed to find the mischief, or if there is much distension, the surgeon must allow the coils to prolapse under hot aseptic towels which are frequently renewed. Every part is then gently and rapidly examined. The objection to this method is, of course, that it is often exceedingly difficult to get the distended coils back into their home, and that the necessary manipulations and exposure must produce shock, and may inflict serious damage. As, however, any other method of examination often fails,‡ especially in cases of distension, and, as time is a matter of great importance, the surgeon must boldly face this method and its risks, where all others are useless.

To effect replacement, Senn advises that Kümmell's method be followed, of resorting to uniform gentle pressure by covering the intestines with a warm moist aseptic compress, the margins of which are tucked in under the abdominal incision ; in this way the coils are protected, and are guided back as the wound is closed by tying the sutures already in place from above downwards. Raising and everting the edges of the wound will help materially the coaxing back of the intestines. Should all attempts fail, incision and evacuation of the most distended coil should be resorted to.* The patient being turned on to one side, the most distended loop is drawn out over a basin, incised transversely to its axis at a point most distant from the mesentery, the rest of the coils being kept under hot aseptic towels. As the escape of gas and fluids, owing to the paralysis of the intestine, will probably be very slow, it will be wise to follow Dr. Senn, and "resort to pouring out the contents, as it were, by seizing the gut several feet above and below the incision, and elevating it," a large quantity of fluid fæces being thus poured out. The opening is then closed by a Lembert's suture of fine carbolized silk. This emptying of distended coils will not only facilitate reduction, but, as pointed out by Mr. Greig Smith (*Abd. Surg.*, p. 436), it will diminish the harmful effects of a greatly distended abdomen—viz., dyspnœa, palpitation, and abdominal shock, and, on the bowels themselves, the danger of continued distension and paralysis.

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* Mr. Greig Smith says that as the most distended coils will rise nearest the surface, and the greater amount of bowel is within 3 inches of the umbilicus, there is a probability that the most dilated coils will be in sight.

† If he find that the bowel is getting healthier and emptier, the surgeon must reverse the direction of his search.

‡ " How difficult it is to find the obstruction in some cases is well shown by Madelung, who, in several cases where the seat of obstruction could not be located during life, requested the pathologist, when he made the post-mortems, to locate the obstruction by introducing his hand through an incision, allowing him from ten to twenty minutes for the exploration ; in every instance he failed to find the obstruction within the specified time " (Senn, *loc. supra cit.*).

Another means of finding the seat of obstruction, which is only available when there is little, if any, distension, is the insufflation of hydrogen gas, recommended by Dr. Senn.† This surgeon, finding that distension of the entire gastro-intestinal canal (for, owing to distension of the cæcum, the ileo-cæcal valve is paralysed) in animals was never followed by any ill effects, has advised this (1) in reduction of intussusception, (2) in locating the obstruction during a laparotomy, (3) in detecting the site of gunshot or other perforations of the intestine. The gas is collected in a 4-gallon rubber balloon, and the inflation made by compressing the balloon. A manometer or mercury gauge connects by rubber tubing the rectal tube on one side and the balloon on the other.

This method, though extremely ingenious, is likely to have but a limited application. In the reduction of intussusceptions the use of ordinary air is much more handy, and has been abundantly successful. In the detection of perforations, especially those by gunshot, the test has certainly answered, but the following *risks* are connected with its use. It will demonstrate perforations, but nothing else, and may lead the operator, if he trusts to it, to overlook many other lesions which may be as dangerous as perforations themselves. Many conditions—*e.g.*, impacted fæces, prolapse of mucous membrane, and recent adhesions—may interfere with its efficacy (Morton). Though aseptic when introduced, the gas can hardly be so after passing through many feet of intestine. It may break down most vital adhesions. It may increase, by the distension it causes, the danger of the anæsthetic.

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* Mr. Greig Smith, who has, in this country, advocated emptying distended intestine by incision, explains the disappointing results of simple tapping, by the fact that distended coils, confined by their mesentery, form acute flexures, down to the second or third of which the gut is emptied and no further.

† *Loc. supra cit.*, p. 53, and *Journ. Amer. Med. Assoc.*, June 1888: "Rectal Insufflation of Hydrogen Gas an Infallible Test in the Diagnosis of Visceral Injury of the Gastro-intestinal Canal in Penetrating Wounds of the Abdomen."

Bands and Apertures*† (p. 759).—In most cases these are not difficult to deal with. If bands do not give way to the finger as attempts are made to hook them up, they should be divided between two ligatures of chromic gut. Occasionally transfixion is required. Intricate kinking of loops may be most baffling. When one band has been discovered, the possibility of a second, attached to the pelvic brim, must always be remembered (p. 767).

In the case of a diverticular band, the question whether to be content with entirely freeing the intestine, or to resect the band as well, and thus make the patient safe in future, will arise. Where the patient's condition admits of it, and where the surgeon has the things needful at hand, I strongly recommend the latter. By packing in sponges, the rest of the peritonæal cavity is shut off, the band or diverticulum is brought as far as possible outside, and dealt with according to its structure. In the case of a band probably omphalo-mesenteric in character, division between two chromic-gut ligatures will be sufficient. If the diverticulum be tubular, the intestine into which it opens being first emptied by pressure, the diverticulum is divided 1½ to 2 inches from the intestine; the cut edges, being next cleansed, are closed first by fine silk sutures taking up the muscular coat, and then by a few which include the serous only.

Volvulus (p. 760).—If, as will probably be the case, attempts at reducing this fail, it should be opened at the summit of the loop, emptied, and fresh attempts at untwisting made; if these are successful, the aperture is closed with Lembert's sutures; if they fail, it is utilized as an artificial anus. A left or right colotomy may be performed, but it is very doubtful if this opening the bowel above will be sufficient, unless the volvulus itself is emptied.

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* As stated at p. 766, some of these, notably Meckel's diverticula, may be expected to give a large percentage of successes.

† An excellent instance of this form of obstruction has been recently published by Mr. H. Marsh (*Brit. Med. Journ.*, June 2, 1888). Here a loop, probably in the middle of the jejunum, had slipped through a hole in the mesentery. The mesentery at this spot seemed of normal thickness and pliability, and the edge of the opening was so yielding that Mr. Marsh could readily stretch it with his finger-nail sufficiently to allow the loop to be drawn out. The patient made a good recovery, though in much danger, for a while, from the paralysed condition of the damaged intestine.

Intussusception.—This has been already fully dealt with (p. 760).

Gall-stones, &c.—Here the following courses are open:—(1) Attempts to pass the stone on into the large bowel. (2) Intra-intestinal crushing either between the fingers or flat-bladed forceps guarded with drainage-tube. (3) This may be facilitated by Mr. Tait's suggestion of puncturing the stone with a needle. A stout electrolysis needle will be best, and the puncture should be made obliquely, 1½ inch from the stone. (4) The loop being drawn outside, the foreign body is extracted, and the opening most carefully closed. If any of the last three are adopted, the stone must be first pushed into an absolutely sound part of the intestine.*

The peritonæal cavity must be next cleansed of any fluids, and above all of any discharges, either by sponges introduced on large Spencer Wells' forceps down into the pelvis and along the costo-vertebral furrows, or by flushing with a hot solution of boracic acid (2 per cent.), or ½ per cent. of salicylic acid, in boiled water: pints of this are introduced by an irrigating tube. After the flushing, sponges are again used, and a Keith's tube inserted. Flushing is always to be employed when the peritonæal cavity has been contaminated.

The opening in the abdominal walls is then closed with sutures of wire, or silk or fishing-gut, care being taken to include the parietal peritonæum, and, as the sutures are inserted, to prevent, by a flat sponge, any blood entering the cavity of the peritonæum.

The advisability of forming an artificial anus is alluded to below.

INTESTINAL ANASTOMOSIS.

This is another ingenious suggestion which we owe to Prof. Senn (*Trs. Inter. Med. Congr.*, vol. i. p. 460; *Intest. Obstruct.* p. 80). It has been brought forward as a sounder, safer, and more rapid way of giving relief in those cases of intussusception and intestinal obstruction where, owing to the patient's condition, and the state of the intestine, or because the site of the obstruction cannot be found, the surgeon is reduced either to resecting the damaged parts or to making an artificial anus. Prof. Senn considers that his method of anastomosis is superior to either of these, and that it will be applicable to a very wide field of cases, such as gastro-enterostomy, making a fistula between the gall-bladder and intestine (*vide infra*), and many other instances. The parts to be operated upon having been shut off from the general peritonæal cavity by sponge-packing, two incisions, 1½ to 2 inches long, are made through the walls of the viscera which are to be joined. The convex border of the bowel opposite to the mesentery should be chosen. Through the two incisions, oval, perforated, decalcified bone plates are inserted, carrying four silk threads, one at each end of the plates, and the other two at the sides. The lateral threads are brought through all the coats of the bowel (Fig. 119), and when the threads are tied the plates are brought together, and hold firmly in apposition two large serous areas, which quickly become united by adhesive peritonitis. The knots are buried between the serous surfaces. The decalcified plates are soon

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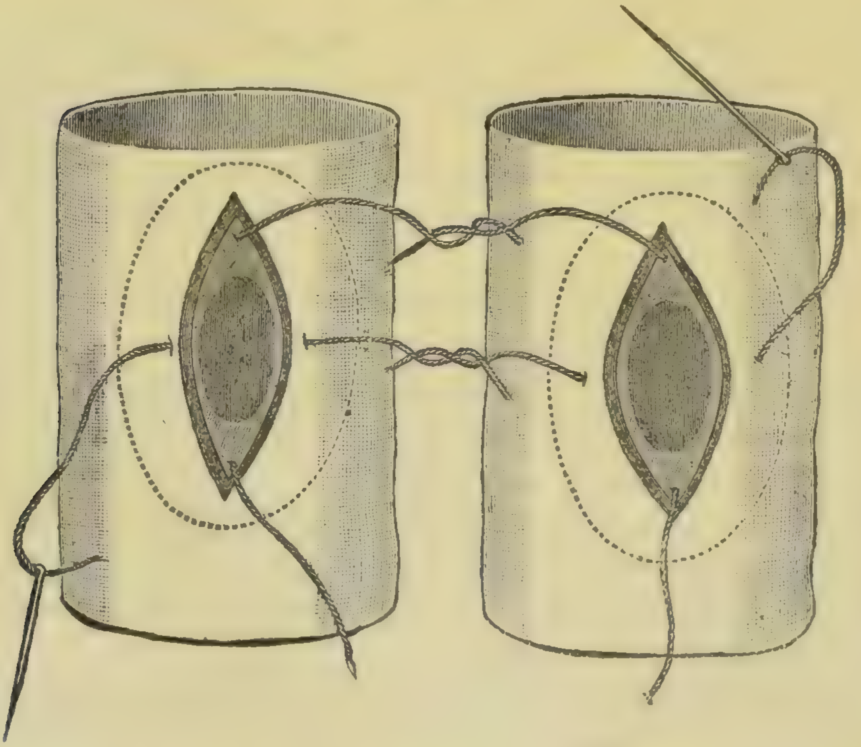
* In one case (*Brit. Med. Journ.*, May 31, 1879), after the removal of a concretion from the jejunum, the bowel was so thinned that, "although it was well stitched with carbolized catgut," it would not hold together. The patient died in four hours.

FIG. 119.



Employment of Senn's perforated plates in intestinal anastomosis. The dotted outlines show the limits of the plates. (Greig Smith.)

absorbed in the intestinal fluids, and the opening is established. The perforations, meanwhile, prevent any risk of obstruction.

The following directions are given for preparing the plates:—Oval plates, 2½ to 3 inches long, ¼ inch thick, and 1 inch wide, are cut with a fine saw from the compact layer of an ox's femur or tibia. They are then decalcified in a 10 per cent. solution of hydrochloric acid, changed every twenty-four hours, till they can be bent without fracturing. The acid is then washed out by letting water flow over them for three or six hours. The plates are next covered with porous paper, and compressed between thin pieces of tin, until they are perfectly dry. This is to prevent warping while drying. The central opening is then drilled out, and enlarged till it is ⅝ inch in length and about ⅙ inch wide. The sharp margins of the plate and perforation are then smoothed down. Four perforations, one at each end and one at each side, are next made with a drill. The plates are preserved in absolute alcohol, and washed in a 2 per cent. solution of carbolic acid before use.

ENTEROTOMY; FORMATION OF ARTIFICIAL ANUS IN ACUTE INTESTINAL OBSTRUCTION.

This is done, under *two chief conditions*: (*a*) when the surgeon cannot detect the site of stricture, or finds that he can neither deal with this, nor perform resection owing to the state of the intestine—he then makes an artificial anus in the middle line; (β) when the surgeon decides, owing to the patient's condition, not to perform an ordinary abdominal section, but to relieve the distension. &c., by opening the bowel above the stricture, usually making use of Nélaton's operation. Neither is more than palliative, and neither should be made use of save when everything else fails, and when the surgeon feels sure that the obstruction is low down in the small intestine.[*] Dr. Senn's method of intestinal anastomosis will probably replace the formation of an artificial anus whenever the patient's condition will admit of it.

Nélaton's[†] Operation. — Right Iliac or Inguinal Enterotomy.

Operation.—The small intestine may be opened low down by drawing a line from the umbilicus to the right anterior superior spine, taking a point a little below the centre of this line as the middle of a vertical incision about 2 inches long. Another method is in use, by much the same incision as in Littré's operation—viz., one parallel with, and about 1 inch above, Poupart's ligament, beginning just outside the site of the internal ring and carried upwards and outwards towards the anterior superior spine.

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[*] If the artificial anus be high up in the small intestine, death from inanition is certain.

[†] M. Nélaton, introducing this operation in 1840, believed that some obstructions would relieve themselves in time if a temporary outlet emptied the accumu-

In either case, the structures are divided down to the peritonæum, and all hæmorrhage carefully stopped. The opening into the peritonæum should not be more than 1 or 1¼ inch long. The first piece of intestine which presents in the wound, or the one which seems to be the most distended, is drawn into the wound and sutured most carefully, two stitches, if possible, being introduced at either end, and three on each side. The sutures should be of silk, or fishing-gut and horsehair. If there is time, peritonæal apposition should be ensured by stitching the parietal peritonæum first to the margins of the wound by a few points of chromic gut. If possible, some hours should be allowed to elapse before opening the intestine. If it is absolutely necessary to open it at once, this should be effected with a small and very sharp trocar, the cannula being left in and plugged. Another means of preventing contamination of the peritonæal cavity would be to turn the patient on one side and wash away the escaping fæces with a stream of some weak antiseptic. Every care should be taken to keep the parts sweet as in colotomy, p. 688. If needful later, the wound must be dilated by sponge-tents. Especial care must be taken to ensure the regular wearing of a plug, and to prevent any accumulation above by regular attention to the bowels and by injections.

Formation of an Artificial Anus in the Middle Line.—This will probably be more frequently made use of in cases where the obstruction cannot be relieved. A loop, as near as possible to the disease, being drawn out, the wound is accurately closed

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lation above; in other cases, where the obstruction was malignant, the relief thus given would be sufficient for the remainder of the patient's life if the small intestine was only opened low down, while this simple operation involved much less shock and disturbance of the abdominal contents. While the above are true, this operation, which is, after all, only palliative, usually fails, from what I have seen, by leaving irrecoverable mischief behind in those very cases to which it is best suited—viz., acute obstruction where the lesion cannot be found or where it is beyond recovery. Another disadvantage is the large amount of intestine above the opening which may remain distended and partly paralysed.

around this, and the bowel is then stitched *in situ* with the precautions already given.

Mr. Greig Smith (*loc. supra cit.*, p. 446) urges that in very bad cases the artificial anus be made by aid of local injection of cocaine.

It is probable that Senn's method of intestinal anastomosis will very largely replace artificial anus.

OPERATIVE TREATMENT OF SUPPURATIVE PERITONITIS.*

Indications.—When a case of peritonitis has resisted other treatment, especially if it show dulness, fluctuation more or less obscure, perhaps œdema of the skin, when the vomiting is so constant that the patient's condition is becoming critical, the peritonæal cavity should be opened and the collection drained.

This may be either diffuse or localized, and the treatment will vary accordingly. The peritonæal cavity being opened by an incision,† either over any localized dulness, œdema, &c., or in the middle line, at first about 2 inches long, when the collection is reached, pus will come out freely, often foul and of varying consistency. The pus may be preceded by a rush of gas ; this will be foul if coming from the ileum or colon. It is said to be less offensive if from the higher part of the intestine, and devoid of any fœtor if from a perforation of the stomach. The pus must all be removed, if possible, by varying the patient's position, irrigation with a hot 2 per cent. solution of boracic acid in boiled water,‡ or 1 in 1000 solution of iodine, or boiled water only, till all runs out clear, and by introducing sponges on holders or in clamp-forceps. Every gentleness must be used, as the peritonæum is soft and altered, and bleeds readily. The question will next arise, if the pus is here and there dammed up in pools by coils of adherent intestine, how far it will be wise to break these down and drain all the fluid away once for all. This must chiefly depend upon these points—(*a*) The age and condition of the patient; (*b*) the strength of the adhesions; (*c*) the character of the pus as to foulness, &c.

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* It is of importance for the surgeon to remember the chief causes—injury, tubercle, certain viscera, *e.g.*, the ovaries, a perforation of the appendix, and, much more rarely, a perforating ulcer of stomach or intestine, or rupture of any intra-abdominal abscess or cyst. Peritonitis arising in connection with the cæcum or appendix is treated by itself, p. 781. The prognosis is best in traumatic cases, especially in those of slow origin. It is worst in cases of perforation, all septic cases, and in those with kidney disease.

† The urine should be first drawn off, and the best anæsthetic will be A.C.E. or ether.

‡ With the condition of peritonæum met with this will be preferable to carbolic-acid or mercury-perchloride solutions, for fear of absorption.

In doubtful cases it will be wiser to follow the advice of Mr. Greig Smith (*loc. supra cit.*, p. 441):—"It is possible, as I can from experience testify, to do too much at first in these cases. The shock of cleansing the abdomen and breaking down adhesions may at once kill the patient, where waiting a day or two, while the advantage of evacuating pus is having its beneficial effect, may give the patient an opportunity of rallying a little. When a little improvement shows itself, abdominal irrigation may be instituted, and if there is a removable cause, this may be treated later on. I am convinced that, in the most severe cases of purulent peritonitis, the safest proceeding is to treat by stages, and not at one operation."

Another question which is quite unsettled is, whether it is wiser to trust to irrigation by a small incision, or to make a larger one, that the surgeon may better see what he is about. The former may be imperfect owing to the limited incision; the latter exposes the intestines more, and may lead to their escape if the patient is moved about to facilitate the outflow of pus. If a perforation is expected the freer incision must be used.

If the collection is an encysted one, it may not be found at once, especially if the median incision is made use of. When the collection is found by the finger, it should, if possible, be opened *in situ*, and the median wound closed, so as to keep the general peritonæal cavity sweet.*

If any cause of the peritonitis, such as ulcer of the intestine or perforated appendix cæci, is found, it must be treated. The ulcer should be closed by tying up, or by Lembert's suture (p. 745) after its edges are pared.

After the removal of the pus, a large drainage-tube or a Keith's tube† should be inserted, before the wound is closed, and every attempt made to support the patient's strength by judicious feeding and opiates.

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* This course was successfully adopted by Mr. Godlee (*Clin. Soc. Trans.*, vol. xix. p. 90). As no cause for the peritonitis was found beneath the opening, the finger was passed down to the cæcum, where mischief was expected, finding slightly adherent coils and giving vent to foul pus. The abdominal wall over the right iliac fossa being projected by the finger passed here from the wound, an incision, 1 inch long, was made. It was now found, on exploring, that the pus came from the neighbourhood of the appendix, which, though thickened, was not ulcerated, and contained no concretion. The patient made a good recovery.

† This may either be sucked out frequently, or kept working by a wick of

TYPHLITIS AND APPENDICITIS.

For the fact that surgical interference in these cases is becoming more valued we are indebted to papers by Mr. Treves in this country and Dr. Bull of New York.*

Indications.—A surgeon is at once met here by the varying opinions held as to the need of surgical interference in these affections. This is to be accounted for by the fact that they are met with under very varying degrees of severity. Thus Mr. Treves (*Surgical Treatment of Typhlitis*, p. 25) gives the following three classes:—(i.) The mild form; (ii.) The severer variety; (iii.) Relapsing typhlitis. Of these, the first is the commonest variety, and one which usually ends in resolution under judicious medical treatment. (ii.) This form is usually severe and acute, and the symptoms marked—viz., rigor, severe pain, marked tenderness and vomiting, and other signs of peritonitis, a tumour or area of dulness above Poupart's ligament, and a swelling, "often to be made out per rectum, and felt to be fixed, not unfrequently the appendix can be identified as an elongated hard swelling about the size of an adult thumb" (Treves). The above symptoms vary in acuteness, and so does the onset of suppuration and perforation. Mr. Treves discusses very clearly the three following points which have to be considered in those cases where suppuration is expected to occur or to have occurred:—(*a*) *The Time at which the Incision should be made.*—The use of the knife will very rarely be called for before the fifth day, except in the presence of very emphatic symptoms. Some eminent surgeons—viz., Dr. Bull, of New York—have advocated very early operation, *e.g.*, 30 to 72 hours after the first symptom, on account of the earliness at which perforation may occur, and the number of too late operations which have been recorded. Mr. Treves is against operating so early because—(1) While such cases of early perforation do exist, they do not afford a legitimate argument for operating as a matter of routine within that early period (say 36 hours) in even the majority of cases. (2) The

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aseptic cotton. This and the dressing over it must be changed as often as they are saturated.

* The case will not be forgotten in which Mr. Symonds, at the suggestion of our colleague, Mahomed, successfully removed a concretion from the vermiform appendix, the cause of recurrent typhlitis. The operation was extra-peritonæal (*Clin. Soc. Trans.*, vol. xviii. p. 285).

large number of cases of spontaneous cure must not be lost sight of. (3) Cases which end fatally within 36 hours by perforation into the peritonæal cavity are comparatively rare; as a rule, the pus makes its way through the abdominal wall. (4) A very small collection of pus is not easy to discover, as shown by not a few recorded cases. (5) By waiting, the pus will be better localized and more directly reached; if a very early incision became the rule, matter frequently could not be reached without first opening the peritonæal cavity, and could not escape without first finding its way into that cavity.

(*b*) *The Use of the Exploring Needle.*—This has been advocated by American surgeons. Mr. Treves strongly condemns it, as (1) it is not free from risk, as it may be thrust into important parts. It may tap an appendix distended with fetid mucus, and, allowing some of this to escape, bring about a suppuration which was by no means inevitable. (2) An incision is more reliable.

(*c*) *The Site of the Incision.*—Most surgeons will agree with Mr. Treves that the middle line and the linea semilunaris should not be chosen, as they do not give good direct drainage, and may lead to infection of the peritonæal cavity. Mr. Treves recommends, as the most convenient, one made obliquely from above downwards and inwards, just outside the deep epigastric, and ending a little above and outside the middle of Poupart's ligament. Others have used a vertical incision running upwards just outside the centre of Poupart's ligament, or one parallel with and just above the outer half of Poupart's ligament. I have found either of the above useful. In one case, a boy aged fourteen, admitted with general peritonitis, I found a gangrenous appendix, and a fæcal concretion lying loose outside it. The appendix was sutured and removed, and the general peritonæal cavity washed out. The patient, whose condition on admission was almost desperate, sank 24 hours later. In the second, an adult, an exploratory incision gave vent to an abscess, which happily was localized. The patient made a good recovery, without relapses, probably from her appendix having been absolutely closed by the acute attack. In the third case the appendix had ulcerated, and there was general peritonitis. The appendix was pared and sutured. and the peritonæal cavity flushed out. The man was most unamenable, demanding solid food, and constantly trying to get up. He sank exhausted on the eighth day.

Operation.—The abscess being opened by one of the above incisions, the cavity should be well washed out by irrigation with some weak antiseptic, and a large drainage-tube (p. 780) introduced. If the appendix (the condition of which is always to be made out, if possible) is perforated or gangrenous, it should be removed after a ligature of chromic gut has been firmly secured round a healthy part of its proximal end. The condition of the organ and of the surrounding tissues forbids a more precise surgical procedure. If the appendix be entirely gangrenous, or perforated close to its point of origin, Mr. Treves advises that it be left untouched, and no attempt made to apply a ligature. So too, when the process is very adherent, it will probably do best if left quite alone. Mr. Treves gives the following cautions—(1) that the careless introduction of the finger may break down important adhesions, and cause perforation into the general peritonæal cavity; (2) that very important structures, *e.g.*, the ureter, may be exposed in the wall of the abscess.

(iii.) Relapsing cases. Mr. Treves has advocated the removal of the appendix during a period of quiescence as the best treatment when the attacks recur, and cripple the patient's life. He cautions us that removal of the appendix has been somewhat recklessly carried out, and that there are a series of cases of relapsing typhlitis which do not depend upon appendicular trouble, and which would not be relieved by resection of the process. He suggests the following points in connection with the *operation*:—(1) The position of the diseased appendix should be made out beforehand if possible. This might have been indicated during one of the attacks. (2) The operation should not be undertaken until all inflammatory symptoms have quite subsided. (3) The incision should be made obliquely from above downwards and inwards over the cæcal region, its lower extremity ending just outside the deep epigastric. The incision should not be made directly over the appendix or the dullest region. If it be so placed, a number of adhesions will probably be encountered, the cæcum or the appendix might be actually adherent to the anterior abdominal wall. The incising of the peritonæum should therefore be conducted with the very greatest care. The parietal cut should enter the abdomen at a point just beyond the diseased area, and where no adhesions exist. (4) When the appendix and cæcum are exposed, the area of the operation should be shut off from the general peritonæal cavity by sponges. (5) All adhesions should be divided by cutting; none should be "broken down." The latter measure is apt to tear the bowel, or at least to bare it of peritonæum. (6) The appendix should be lightly clamped close to the cæcum and divided about ½ inch from that intestine; it should not be secured by a simple ligature. The mucous membrane should be united by many fine sutures, or by a continuous suture; then the divided outer walls should be brought together by a second row of sutures. When the walls are greatly thickened, it is practically impossible to bring the serous coats together. To still further secure the orifice the stump might be lightly attached to any adjacent surface of peritonæum. (7) The abdominal wound should be closed; no drain is required. Mr. Treves concludes with one more warning—that while some of these cases are very simple, in others the matting of parts is almost inextricable, and the risk of wounding bowel, ureter, or important vessels is considerable.

CLOSURE OF ARTIFICIAL ANUS.

Indications.—Cases where the opening dates to injury, hernia, &c., and admits of being safely closed; when, owing to its site being high up in the intestine, serious marasmus is threatened, and when sufficient time has elapsed and enough trouble* has been taken to make it certain that there is no hope of spontaneous closure. The patient's condition and strength must be satisfactory.

Operation.—I know of no clearer account than that of Mr. Makins.† The skill with which this operation was carried out was only equalled by the thoughtfulness with which it was planned.

The patient was aged twenty-one. The artificial anus, dating to a herniotomy, was high up in the small intestine, and opened about ½ inch above the centre of Poupart's ligament. Here, at the bottom of a small pit, the mucous membrane of the intestine was slightly prolapsed. The gut was firmly attached: the finger only passed into the upper opening; the lower could not be found. First, the usual eczematous condition was very much improved by the use of a small shield, and mopping away of discharge with absorbent wool. No food was given by the mouth after the evening of the second day before the operation, nutrient enemata being given every four hours. During the day before, the upper end of the bowel was washed out with injections of salicylic lotion. As bile-stained fluid was escaping from the fistula an hour before the operation, this washing out was repeated. Before beginning the operation a bit of carbolized sponge attached to string was passed for 2 inches into the upper end of the bowel. A vertical incision of 2½ inches being made through the abdominal wall, the upper end of the intestine, normal in size, was dissected free from its adhesions; the lower end lying just below it was contracted to the size of a pencil, with an opening only large enough to admit a director.*

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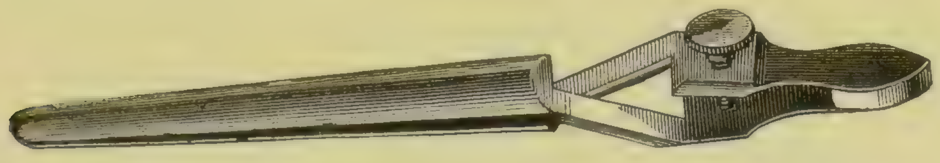
* When both openings are easily found, trial should be made of a simple and ingenious method of Mr. Banks (*Clin. Notes*, p. 94). In an artificial anus in the groin, after a femoral hernia, he introduced a thick piece of india-rubber tubing into the opening, and pushed one end up the ascending bowel and the other down the descending. It was fastened by silk hanging out of the opening. It was calculated that the pressure of the tubing against the projecting spur would press it back, and allow the fæces to pass round the corner without flowing out of the artificial anus. At the end of seven weeks nearly all the fæces passed by the rectum instead of by the artificial anus, this being reduced to a sinus, giving vent to a few drops of yellowish fluid. At the end of three months this completely closed. According to Mr. Makins (*loc. infra cit.*), the average duration of Dupuytren's method varies from four and a half to twelve months. Mr. Barker has suggested the use of Spencer Wells' forceps to destroy the spur.

† *St. Thomas's Hosp. Reports*, vol. xiii. p. 18.

The two ends of the gut being now provisionally clamped with forceps (Figs. 120, 124), sheathed in tubing, they were drawn out, and a number of sponges attached to string packed round them. The sponge was then drawn from the upper end of the intestine, and about 1 inch removed from the upper end and 2½ from the lower one, together with a wedge of mesentery 4 inches long by ¾ inch wide. The cut surfaces then nearly corresponded. The bleeding points having been tied in the mesentery, this was united with six silk sutures, and the gut then sutured as follows:—A first row of twenty-five very fine Chinese-twist stitches were passed with a small curved needle through the whole thickness of the gut, about $\frac{1}{10}$ inch from its free margin, commencing at the mesenteric border. These were tied in batches of five at a time. Then a second row of Lembert's sutures (Figs. 122, 123) were passed and tied in the same manner.

FIG. 120.



Mr. Makins' clamp-forceps, for use in resection of intestine.†

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* Over two months had elapsed since the formation of the fistula, and one month since the last proper action of the bowels.

† Mr. Makins prefers these clamps as less cumbrous than any others. If fingers are used, the compression varies a good deal, and dries and damages the intestine. If a temporary ligature of catgut is made use of, and passed through the mesentery, it puckers the bowel and prevents even stitching. The use of fine drainage-tubes (p. 798) is equally efficient, and superior to any other in simplicity.

During the stitching, which took about three-quarters of an hour, the gut was kept moist with warm salicylic lotion. After the bowel was closed and returned, it was found impossible to close the whole wound. As this could only be brought together above and below, the granulations were shaved away and the intestine left at the bottom of a deep pit. Iodoform-gauze and pine-wood dressings were applied. The patient made a good recovery. Two days later the intestine could be seen at the bottom of the wound covered with lymph and showing vermicular movements. The bowels acted naturally two days after the operation. No fæces came by the wound, but twelve sutures were thus discharged.

ENTERECTOMY.—COLECTOMY.

Indications.—Many of these must be considered unsettled. While for artificial anus in such a case as that of Mr. Makins, where such conditions are present as those of increasing marasmus in an otherwise healthy patient, or in cases of limited injury to the gut, the operation may be unhesitatingly entertained; it is otherwise, I think, in many of the other cases in which it has been performed—viz., gangrenous intestine and malignant disease. These are, it seems to me, instances of the way in which modern surgery has planned and carried out operations which have got far in advance of the strength of our patients. Where gangrenous intestine, as after hernia or intestinal obstruction, is met with, owing to the critical condition of the patient, and the unsatisfactory condition of the intestine in the vicinity of the resection, no more should, as a rule (p. 790), be attempted than the formation of an artificial anus, the two ends of the gut being brought outside, and their union left to another date.

Again, in malignant disease, do the published cases show that it is worth the patient's while, save in a few most exceptional cases, to undergo the great risk of resection, while the probability is so great that glandular enlargement or other deposits are present, and while there is abundant and certain evidence that colotomy, if performed in time, gives such distinct prolongation of life and such marked relief? It must not be forgotten that in many of these cases of resection of the intestine for malignant disease the surgeon will, partly from the extent he has been obliged to remove, partly from the condition of his patient, be obliged to complete his operation in two stages, with a prolonged interval between them, and that, if secondary deposits are present, the time for the completion of the operation may never come, and thus the patient, having run a greatly increased risk, will be in no better condition than if he had only been submitted to colotomy.

Operation.—This will include:

1. *The Incision.*—The site of this must vary, as no definite rule can be laid down here. Thus, (*a*) Mr. Bryant (*Med. Chir. Trans.*, vol. lxv. p. 131) successfully performed colectomy through a colotomy incision. Time alone will show how many cases of malignant disease are, both in position and limitation, suitable cases; I fear but few. (*b*) The incision in the linea alba: this has the advantage of affording an opportunity to explore in doubtful cases, of giving room by allowing of extensive enlargement, and of thus, perhaps, reaching secondary deposits in the glands. (*c*) An incision over the growth, as in the right or left inguinal regions, or, as suggested by Mr. Whitehead (*Brit. Med. Journ.*, Jan. 24, 1885), as a convenient compromise between these and that in the linea alba, an incision along the outer border of the rectus.

2. *Isolation of the Growth.*—By whatever incision the growth is exposed, the surgeon will next have to decide whether isolation is feasible. He may find a growth isolated and apparently free from secondary deposits, and thus suitable for resection, but so fixed as to make it impossible to bring it up into the wound by any amount of traction that can be called safe. In such a case the operation had best be abandoned, and colotomy substituted in the case of the large bowel. Other indications for abandoning resection will be glandular enlargement, if at all extensive, and adhesions of the affected intestine to neighbouring parts.

3. *Resection of the Intestine.*—If it be found possible to bring up the intestine into the wound,* and feasible to resect it, sponges are carefully packed all around so as to shut off the peritonæal cavity, and the bowel, resting on hot aseptic cloths, is occluded just above the intended sites of section, either by the fingers of an assistant, drainage-tube (p. 798), or by clamps. Of these, Mr. Makins' (Fig. 120) are as simple and efficient as any. The diseased portion is then cut away with a triangular wedge of mesentery, the base corresponding exactly to the part of bowel removed. Any vigorously bleeding points are now tied with fine catgut, and the edges of the mesentery brought together with continuous or separate points of suture of the same material.

4. *Suture of the Intestine.*—After resection of the intestine and

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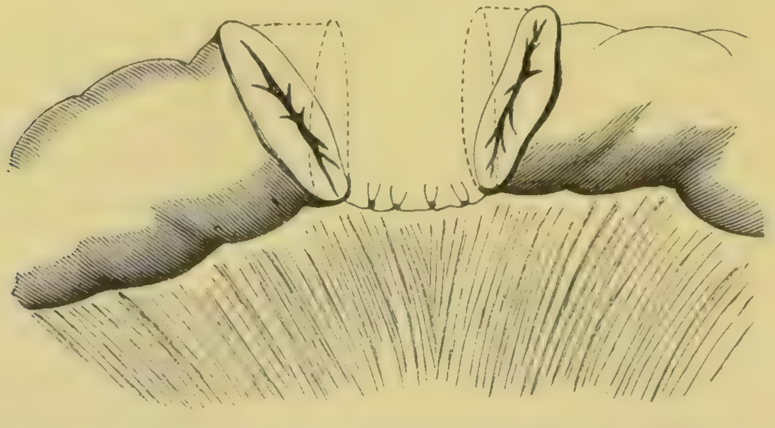
* The softened condition of the bowel at the site of disease, the varying length of the meso-colon, &c., must be borne in mind.

mesentery, the ends of the cut bowel are carefully emptied, cleansed, and brought into apposition, a point of some difficulty owing to the eversion of the mucous membrane (Fig. 121). Of the numerous forms of sutures, most have become obsolete.

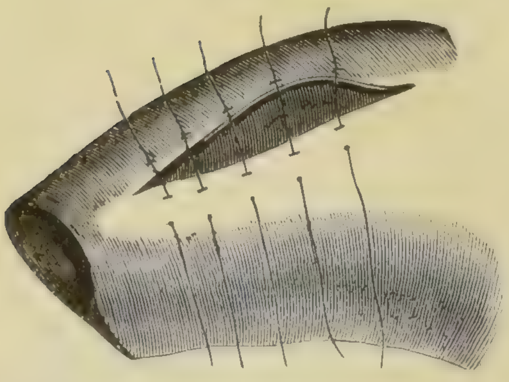
FIG. 121.



This shows the appearance of a completely resected bowel with its edges much everted prior to the introduction of sutures. Four stitches have been inserted in the mesentery to join its two cut edges. (Mac Cormac.)

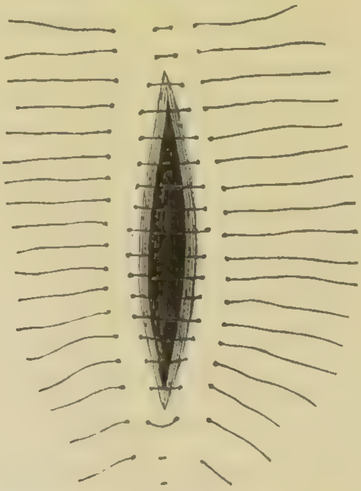
Two modes only will be described here. In one a double row are inserted; the first, being tied within, take up the mucous membrane only. Fig. 134 shows their mode of introduction. An external line of sutures is then applied after Lembert's method. Each of these should be inserted not less than ⅓ inch from the cut edge, run along in the muscular or between the muscular and serous coats; it is then made to emerge just wide of one cut edge, re-inserted just beyond the opposite edge, then at once made to travel between the coats and to emerge as before. This method

FIG. 122.



Five sutures introduced by Lembert's method. (Mac Cormac.)

FIG. 123.

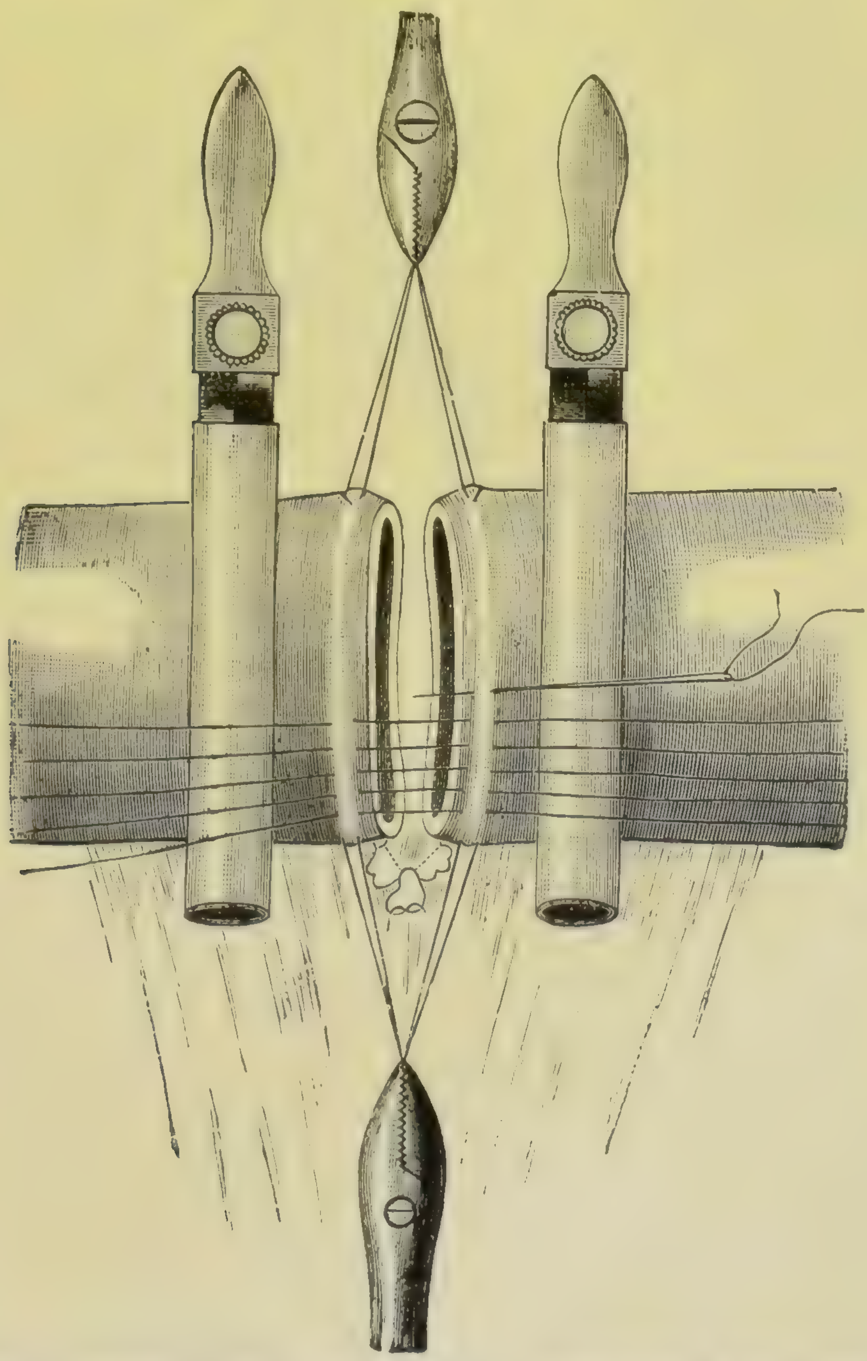


Lembert's suture, as used by Sir W. Mac Cormac in two successful cases of intra-peritonæal rupture of the bladder.

has the advantage of turning in and keeping in contact the peritonæal membrane which bounds the edges on either side.

In the other mode of suturing, the above suture of Lembert's is alone trusted to, without any internal row in the mucous membrane. Sir W. Mac Cormac thinks that the single row is enough, as long as a sufficient width of surface is taken up.

FIG. 124.



Suture of resected intestine. (Greig Smith.) Two sheathed Makins' clamps are in position. The mesentery has been divided close to the intestine. Its cut edge is drawn together by a purse-string stitch, which leaves free small flaps of peritonæum, which can be grafted on to the base of the line of union. Four sutures are inserted into the opposite sides of the resected gut, and careful traction made on them by an assistant. This raises a well-defined fold along the edge of the gut, which makes the insertion of suture more easy and regular.

Fine Chinese-twist silk, thoroughly carbolized, is the best material, and a sufficiency of fine round needles (so that the aperture is at once plugged by the thread) should be at hand. Flat needles, however, if only fine enough, will serve the purpose well. Different curves should be provided, and two or three needle-holders, and the operator must be kept well supplied.

One or two points require special attention. The sutures should be inserted about $\frac{1}{6}$ inch from each other, and from twenty-five to forty will be required in the two rows together, each being inserted, as far as possible, at an interval between two others. The chief attention is needed at the attachment of the mesentery, the outer sutures being dipped here well into the muscular coat, so as to bring the serous surfaces firmly in contact, and thus avoid any extravasation into the triangular interval which here exists at the separation of the peritonæum into two layers.

When all the intestine is closed, it is cleansed, and gentle pressure is made, after removal of the upper clamp, to see if the contents pass beyond the line of suture safely. If all is water-tight, the parts are again thoroughly cleansed, all sutures of uneven length trimmed, the protecting sponges removed, the neighbourhood made clean, and the intestine and mesentery returned, having finally had a little iodoform dusted on and rubbed over it. The wound is then closed in the usual way.

While these sheets are passing through the press, the treatment of gangrenous intestine in strangulated hernia has been quite recently brought before the profession by Mr. Lockwood and Mr. W. A. Lane (*Brit. Med. Journ.* 1891, vol. i. pp. 701, 1071), in papers advocating resection of the damaged intestine. Mr. Lane, who had had a successful case, after resection of the gangrenous gut, closed the two ends, and then made a short circuit between them, by making openings about 3 inches from the closed ends, and joining the openings by Senn's plates. The majority of surgeons present were against any general adoption of this treatment. Each case must be decided by the condition of the patient, the experience of the operator in abdominal surgery, the facilities for aseptic surgery, the presence of skilled help, &c.

CHAPTER VI.

OPERATIVE INTERFERENCE IN GUNSHOT AND OTHER INJURIES OF THE ABDOMEN. RUPTURE OF THE INTESTINE.

GUNSHOT AND OTHER INJURIES.

We owe the great advances lately made here, in the first place, to antiseptic surgery, and, in the second, to the zeal with which American* surgeons have taken up the matter and made known their results, unsuccessful as well as successful.

1. *Examination of the Wound, with Regard to Penetration.*—Blackening of the wound and the clothes with powder suggests a close shot and probable penetration. Edges clean cut and equally stained show that the bullet has struck perpendicularly; unequal staining and raggedness suggest obliquity of impact, and the less perpendicular this is, the less the probability of penetration. If there exists a continuous track of tenderness, especially if accompanied with slight redness, from the wound for some distance over the abdominal surface, it is fair to infer that the missile has wormed itself between the layers, without penetration (Parkes).

2. *Symptoms indicating Penetration.*

(*a*) Circumscribed dulness and bulging near the wound, fluctuation in the peritonæal cavity, or either of the last two felt per rectum or vaginam, indicate wound of a large vessel and accumulation of blood, and penetration, with visceral injury, probably; but, to be diagnostic, it must come on within a couple of hours. (β) Rapidly† forming tympanitis indicates penetration and escape of gas from the intestine. (γ) Escape of fæces, bile, or urine from the wound is, of course, diagnostic of penetration, but rare.

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* In addition to the American writers I have quoted below, I have had the advantage of reading a very careful study of this subject by my old dresser, Dr. J. H. Barnard, now of Paris, *Des Plaies de l'Intestin par Armes-à-feu* (Thèse pour le Doctorat en Médecine. Paris. 1887).

† If delayed, the tympanitis may be due to paralysis of the intestines from shock.

(δ) Repeated hæmatemesis indicates penetration and injury to the stomach or small intestine high up. It may, however, be due to contusion. (ε) Profuse hæmorrhage per anum points to penetration and injury of intestine, but is seldom seen sufficiently early to be of value. (ζ) Hæmaturia indicates injury of some part of the urinary tract. (η) Escape of blood from the wound, if too profuse to be accounted for by a wound of a vessel in the abdominal wall, points to penetration and visceral injury. (θ) Paralysis of any part below the level of the wound is a most grave complication, indicating, as it does, injury to cord or nerves as well as, probably, to viscera. (ι) Shock. This does not go for much unless hæmorrhage is clearly present also, owing to the great difference in individual peculiarities.

Other points will be, the size of the bullet and amount of fulminative or powder, the distance and direction in which the firearm was held. A single opening gives, *per se*, a faint hope that there is no penetration.

In cases of doubt as to penetration, the wound will be first explored,* then enlarged, and the line of damage to the tissues carefully followed up, any exploring instruments being kept strictly aseptic.

3. *Probable Amount of Damage.*—Dr. Parkes (*Ann. of Surg.*, November 1887) gives the following suggestions :—" An antero-posterior shot below the level of the umbilicus and well towards the lateral surfaces of the body will be very likely to miss the small intestines entirely, and expend its damage on the large bowel. The same kind of wound high in the lateral surfaces may pass into or through the liver without injuring the intestines, or the spleen alone if the entrance is on the left side.

" If the wound is so situated that the bullet enters the abdomen through the diaphragm, adding injury of abdominal viscera to that of the contents of the chest, the surgeon's help will probably be of little use. A wound of entrance and exit, or an entrance wound alone, showing passage of the ball from side to side through the abdomen, means the worst of injuries, and suggests the need of the greatest care in staying of hæmorrhage, repair of intestines, and toilet of the contents.

" Antero-posterior perforation, if complete, can only fail to wound the small intestines when situated well on the outskirts of the surface of the abdomen ; seemingly there can be no exception to this proposition, save in those extremely rare instances in which the perforating body traverses the cavity without injuring the contents.

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* Any probe used should not be too fine or sharp pointed. A clean bougie will usually be preferable. The old advice not to probe or explore these injuries must, nowadays, be considered exploded.

"Penetration through the posterior walls of the cavity, if complete, with likelihood of laceration of important fixed organs, argues an injury of the most severe character, one in which the surgeon's aid will be of no avail in the majority of cases. The exceptions in which the severity will not prove insurmountable will be, transit through the space between the lower end of the kidney and the crest of the ilium, and in wounds occupying the outskirts of the entire posterior surface. . . . . Many instances are recorded of recovery from posterior penetration of the large and fixed viscera of the abdomen without any surgical operation."

Question of the Advisability of Operative Interference.—While some cases of penetrating wounds with very severe injury (*e.g.*, perforation of intestine and wound of solid viscera) have occasionally recovered, the proportion here is extremely small—Prof. Nancrede gives 8 per cent.;* death from septic peritonitis or hæmorrhage is so common as to justify our urging, in most cases, *as early an operation as is possible, after the diagnosis of peritonæal perforation is made.* The exceptions would appear to be, cases where sufficient time has elapsed to allow of much extravasation and the onset of a peritonitis which is certain to be fatal whatever is done, cases of injury to the spinal cord, severe wounds of the solid viscera, and those where such grave collapse, not due to hæmorrhage, is present as to make it certain that the needful interference with the contents of the abdomen will be necessarily fatal. With regard to the presence of peritonitis, Mr. Greig Smith writes (*loc. supra cit.*, p. 704): "Undoubted and severe peritonitis existing on the second and third day is by most authorities recognized as a contra-indication. In such cases it is improbable that the sites of perforation could be found; and, if they were, that they could be dealt with without the production of excessive traumatism. There is little use in cleansing the cavity if it is to be at once refilled, and there is little use in looking for the perforations if they can neither be closed nor fixed in the wound, while there is positive danger in adding to the risk from traumatism. In such cases the most that can be done is to make a small parietal opening with the help of local anæsthesia, and permit the discharge of the noxious fluids, giving the patient the benefit of the remote chance of spontaneous cure with intestinal fistula."*

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* With regard to the mortality after operative interference, Dr. T. S. K. Morton, of Philadelphia ("Abdominal Section for Traumatism"), says that 97 American surgeons operated upon 165 cases, with 62 recoveries and 105 deaths, a mortality of 65.45 per cent.; while 64 foreign surgeons operated on 69 cases, with 34 recoveries and 33 deaths—a mortality of 47.82 per cent.

Prof. Nancrede (*Ann. Surg.*, June 1887, p. 474) thus states the advantages of an operation:—"We can either forestall septic peritonitis or reduce its dangers to a minimum; we can prevent sapræmia—a common cause of death, as I believe. . . . . Should peritonitis have set in, we can afford sufficient drainage for the effusions, which may in themselves be already poisonous, or, as we have shown, will assuredly become the chief cause of danger; we can substitute for adhesions of doubtful permanency certain methods which secure the escape of the injured portions of gut into the lumen of the bowel; we can prevent the fatal results which must follow the casting off of a decomposing slough of a wounded portion of omentum or mesentery into the general peritonæal cavity; we can arrest hæmorrhage, which from its amount will prove fatal, or from decomposition will equally produce lethal result; we can restore the continuity of the gut, if it be nearly or completely severed, the former condition being not uncommon; we can avoid the risk of fæcal fistula . . . . and we can remove a hopelessly damaged kidney or spleen, and repair a wounded pancreas or liver."

Operation.—An excellent account of this will be found in the very helpful article of Prof. Nancrede to which reference has been already made.

With the utmost care the preliminary details of preparation are entered into first—viz., the cleaning and shaving of the skin, the providing of abundance of water recently sterilized by boiling, or a 2 per cent. solution of boracic acid, or a ¼ per cent. of salicylic acid. Most scrupulous cleansing of instruments. Plenty of soft old linen, lying in the hot sterilized water, to cover the intestines with. Abundance of ligatures of gut and silk of different sizes.† In addition to the instruments given at p. 770, two pairs of Makins' clamps (pp. 785, 789) or a fine drainage-tube should be at hand (p. 798).

"Now as to technique. The patient's limbs and trunk must be carefully wrapped in blankets, with towels, wrung out of the aseptic or antiseptic solution, tucked under and folded over them around the abdomen to prevent any accidental contamination of

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[*] Dr. Barnard (*loc. supra cit.*, p. 58) quotes Dr. Hamilton, of New York, as of opinion that operative interference is contra-indicated if forty-eight hours have elapsed since the accident.

[†] The temperature of the operating-room should be about 75°.

the peritonæal cavity. If not previously done, the urine should now be drawn off. . . . . Ether should be most cautiously administered. The incision should always be median,* as otherwise it is almost impossible to gain a proper view of the parts, and should usually extend from a short distance above the umbilicus to about 2 inches above the pubes. The abdomen having been opened, any clots or blood which obscure the operating field may be removed, but otherwise, unless it is manifest that severe hæmorrhage is going on, the small intestines,† which usually first present, should be carefully gone over, inch by inch, from the stomach to the ileo-cæcal valve, keeping them constantly enveloped in towels wrung out of hot water (sterilized); afterwards the stomach, spleen, liver, pancreas, large bowel, kidneys, bladder, omentum, mesentery,‡ and abdominal vessels must be examined. I do not mean that, if various wounds are discovered, say in the small intestine, and the place of exit of the ball from the abdominal cavity, all in such relations as would absolutely exclude injury of the stomach,§ liver, kidneys, spleen, or bladder (p. 949), such a detailed examination should be made—far from it, for every unnecessary manipulation is injurious; but I do advise that, rather than overlook a wound, much manipulation which the result proves to have been unnecessary had better be made. Of course the source of a severe hæmorrhage must be at once sought for, and any wounds of the hollow viscera ignored for the time being, care, however, being taken that the general peritonæal cavity is protected from fæcal extravasation by removing the intestines outside the abdomen, keeping them wrapped in warm, moist cloths; such hæmorrhage is, however, most unusual. Whichever plan is pursued, let everything be done methodically, and each injury repaired as it is detected, as this saves much time and renders any oversight almost impossible. All wounds of the bowel, however trivial, should be minutely cleansed, coaptated by the Lembert suture of fine silk introduced with an ordinary sewing-needle, and the suture line rubbed over with a little iodoform.* When necessary from the size or number of the wounds, a portion or whole calibre of the gut must be exsected.† Wounds of the liver, if situated at the free border of the organ, should, if possible, be

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* This point has been much disputed. No hard-and-fast rule should be made, but as a rule the incision should be median. Mr. Greig Smith points out that the following cases require it:—Cases where the ball has crossed the middle line, entering at one side and passing towards the other, and in others where the ball, entering near the middle line, passes either directly backwards or in an uncertain direction. I have alluded to this matter later (pp. 799, 800).

† Dr. Barnard (*loc. supra cit.*) points out that wounds of the duodenum are very rarely met with, and that wounds of the upper aspect of the transverse colon and of the omentum at this level are amongst the most difficult to discover.

‡ "Wounds of the mesentery, when they are but perforations, can be passed without any additional interference, unless attended with hæmorrhage, in which case deligation of the injured vessel is required. Large lacerations should be closed with a running suture to avoid the future possibility of an incarceration and obstruction of a loop of the intestine in the opening. On account of the extreme delicacy of the membrane, its closure is often attended with some difficulty, which may be frequently overcome by introducing the sutures near the edge of a vessel, as this region affords the strongest grasp for the suture" (Shackner, *loc. supra cit.*). If it be the omentum which is wounded, or contain a large hæmatoma, it should be ligatured and cut away.

§ Cases of wounds of all these viscera have been treated by laparotomy and suture. Thus Mr. Dalton, of St. Louis (*Ann. of Surg.*, Aug. 1888), records a case of bullet-wound of stomach and liver thus treated successfully. The wounds in the stomach were those of entrance and exit, and situated, the former on the anterior surface, the latter near the upper border; both were closed with Lembert's suture. The lower margin of the left lobe of the liver was ploughed through by the bullet 1¼ inch from the transverse fissure, leaving a V-shaped wound ½ inch in depth. This was closed by one catgut suture, of large size, passed, on either side, an inch from the margin of the wound, and dipping deeply, on account of the great friability of the tissue, into the liver substance. "It

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acted well, bringing the wound together snugly." There were no other injuries save a slight contusion on the transverse colon, probably due to the spent violence of the ball, which was not found. The operation was rendered difficult by repeated vomiting of black grumous fluid, necessitating turning the patient on his side each time, "which was awkward with an open belly." The operation was a prompt one—two hours after the injury; recovery excellent. In Dr. Keen's case (*Med. News*, May 14, 1887) the wound of entrance of the stomach was near the pylorus on the anterior surface, that of exit much more difficult to find, being on the lower border and posterior surface, and obscured by clot. Though there were other most serious injuries of superior mesenteric vein and right kidney requiring nephrectomy, the patient survived till the fifteenth day, death being due to diffuse suppuration of the clot in the mesentery, and gangrenous perforation at one spot in the intestine. Other means of meeting hæmorrhage from the liver are plugging with a tampon of aseptic gauze when the wound is large and the hæmorrhage great, and applying firm pressure, and, in the case of obstinate oozing from an abrasion, the application of a crystal of iron persulphate, or the Paquelin's cautery. Wounds in the gall-bladder are treated like those of intestine. Wounds of the kidney or spleen must be treated, according to their nature, either by styptic, cautery, or suture, as in the liver. If the hæmorrhage is too severe for the above, the organ must be removed. Dr. Keen, in his case alluded to above, the kidney being badly lacerated, adopted this step. The ureter should be examined, and, if divided, the kidney should be removed.

* Wherever possible, the sutures should be introduced parallel with the long axis of the intestine, as by this its lumen is least narrowed.

† Of all the wounds of the intestine those of the rectum are most difficult to detect, and therefore very fatal. Dr. Morton (*loc. supra cit.*) suggests that inflation with a rubber bag may be of assistance here. He also alludes to two cases in which the diaphragm was wounded. In each case a hernia of viscera into the thorax existed; this was reduced, the wound sutured with catgut, and recovery ensued.

coaptated with dry aseptic gut, which will soon swell and fill the track made by the needles. If this cannot be done, the hæmorrhage may perhaps be arrested by the judicious use of the thermo-cautery. Unless the bleeding be free, the wound should be plugged with an iodoform-gauze tampon, which is to remain permanently, or may, perhaps, be carefully removed at the close of the operation, when, if the bleeding be almost entirely checked, the cautery may be used as a further precaution; if the flow be free, the tampon must be replaced and allowed to remain permanently.

"Wounds of the pancreas, spleen, or kidneys must be treated in a similar manner, or, if these measures fail, either spleen or kidney must be excised. Since a wounded splenic artery would lead to gangrene of the organ, it must be removed. The same advice holds good for wound of a renal artery, but in these cases death from hæmorrhage will usually result before art can intervene; still, such possible complications must be provided for. Wounds of the bladder had best be sewn with dry chromic and sulphurous acid gut, which, by its swelling, will fill the track of the little wounds; and the needle should be a round one, as small as can be made to carry the thread. Contused bowel will almost certainly slough, so that the injured portion had better be excised and the healthy peritonæal surfaces united by suture. Wounded or contused omentum or mesentery must also be excised, and the edges carefully united by interrupted sutures. The experience of at least one case has shown that since an omental slough cannot be eliminated into the lumen of the bowel, as occurs in wounds of the intestine, a fatal generalized peritonitis will result from the local gangrene. All bleeding must be checked, even from the smallest vessels, for quite extensive oozing will occur from most insignificant vascular orifices, because they are situated in a closed cavity, and, although the amount lost may not be dangerous *per se*, it will prove so as a source of septicæmia or peritonitis."

This was so in Dr. Keen's case (*loc. supra cit.*). The hæmorrhage here extended fan-shaped in a moderately thick layer between the two layers of the mesentery, its periphery extending almost 2 feet along the bowel, and its point being at the mesenteric attachment to the spine. The chief bleeding came from a hole in the superior mesenteric vein, and was secured after much difficulty by a laterally placed ligature of chromic gut. In spite of most careful antiseptic precautions and unremitting after-treatment, the patient died, on the fifteenth day, of suppuration in this clot, and gangrene of the intestine connected with this part of the mesentery. Wounds of the spleen must be treated by the methods already given for the liver and kidney. The treatment of those in the bladder is given fully later (p. 949).

"If a segment of bowel is to be excised, the cuts should be made at such points as correspond to the distribution of a large mesenteric branch, in order to secure a due blood-supply to the edges of the incisions, and the parts to be removed should be laid upon a large flat sponge, or folded napkins, to prevent fæcal extravasation into the abdominal cavity. To avoid escape of fæces during excision of intestine, the simplest of all clamps is small rubber tubing made to pierce the mesentery on each side of the wound, at a spot devoid of vessels, passed round the intestine, and knotted once (Dr. Shackner, *Ann. of Surg.*, June 1890). To obviate kinking[*] of the bowel, a V-shaped piece of the mesentery must be removed, the branches of the V not corresponding to the cut edges of the bowel, but presenting a free margin of $\frac{1}{8}$ inch, lest want of vascularity cause failure of union at this the most doubtful point. After arresting hæmorrhage, the mesenteric wound must be carefully coaptated by numerous points of interrupted suture.[†]

"Should the pulse fail at any time during the operation owing to irritation and paresis of the abdominal sympathetic, flushing the intestines and peritonæal cavity with hot water will often at once remove the unfavourable condition. The most scrupulous care must be exercised in the peritonæal toilet, which can be most quickly and effectively made by thorough irrigation of the cavity with warm sterilized water and subsequent careful removal of all fluid in the ordinary manner by sponges, especial attention being paid to the case of the pelvis and the renal regions.

"When possible, the peritonæum should be united over the orifices of entrance and exit of the ball,[‡] and a little iodoform rubbed in. . . . .

"When incipient peritonitis exists at the time of operation, with the probable formation of large quantities of acrid septicæmia or sapræmia inducing serum, drainage should in all cases be instituted. . . . . The tube, preferably of glass, should have its end kept well down between the bladder and rectum in the male, or in Douglas's cul-de-sac in the female, with the external orifice plugged with iodoform cotton."

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[*] Where the part of the intestine exsected is small there is no danger of kinking, and no removal of mesentery is needed.

[†] Where the security of the suturing of a severe wound of intestine is doubtful, Dr. Senn's plan of giving support by attaching a piece of omentum should be used.

[‡] If the track of the ball is likely to be septic, it should also be treated by incision, cleansing, and drainage.

As many of the above points must be considered, till more cases give us better light, still *sub judice*, I have added, for contrast, the views of another American surgeon, Dr. McGraw, of Detroit (*Trs. Amer. Surg. Assoc.*, May 1889). It will be seen that in some most important points—*e.g.*, the site of the incision and the question of how best to examine the intestines—they are directly opposed to those of Dr. Nancrede. Dr. McGraw's chief propositions are as follows:—(i.) Bullets which enter the abdominal cavity pass in a nearly absolutely straight line from the orifice of entrance to that of exit, or their final stopping-place in the viscera. (ii.) An incision made directly in the course of the ball will give the shortest route to the injured parts. If balls pass through the abdomen in straight lines, a cut over the path of a ball will open the nearest possible way to the wound underneath, provided the viscera have not shifted their places since the shooting. Even then they could be easily brought into the wound for the purpose of repair. Coils or viscera which could not be so brought could not possibly have been struck by the ball. (iii.) If a gunshot wound of the intestine will not under pressure permit discharge of its contents, it has been closed by the eversion of the mucous membrane or by the exudation of plastic lymph. In either case the wound would probably recover without suture if kept perfectly aseptic, and if the bowels are kept perfectly quiet. (iv.) An empty condition of the alimentary canal is most favourable for healing. To secure this as far as possible, it may be proper, in some cases of injury of the bowel after a hearty meal, to evacuate the stomach by a siphon. This would be especially indicated in wounds of the stomach, duodenum, and upper part of the jejunum, whether the surgeon does or does not decide on operative treatment. In small wounds of the stomach and duodenum suture may sometimes be omitted if the surgeon can be assured that these viscera are empty. (v.) Senn's method of hydrogen-gas insufflation (*supra*, p. 773), however admirable in recent cases, should be used with great caution after the lapse of a few hours. The distension and motion of the gut caused by the insufflation might rupture inflammatory adhesions, break open intestinal wounds that had nearly healed, and make a peritonitis general which had become circumscribed. (vi.) The dangers of the operation are directly in proportion to its length, and to the amount of evisceration. The length of an operation may be lessened—(1) By strictly limiting the examination of the viscera to such of them as may have been in the course of the ball. (2) By suturing wounds in the gut, wherever it is possible, instead of excising them. The latter should be reserved for wounds that do not permit inversion and suture. (3) By omitting all operative procedures, even suture, in all wounds which have become so thoroughly occluded by plastic material that the contents of the bowel cannot be passed through them. (4) When many wounds occur near together, by operating first on those wounds which imperatively demand it, and leaving to the last those which may recover without operation. If the stomach and intestine are both perforated, the small intestine should be first attended to, as the stomach, if empty, may recover without suture. So, too, large wounds should be sutured before small ones, discharging wounds before those which are occluded. (5) By never turning out all the intestines except, first, when hæmorrhage is otherwise uncontrollable; or, second, when there is evidently a discharging wound which cannot otherwise be found. "The examination of the whole intestine by slipping it from one end to the other, through the fingers, though not causing the exposure of evisceration, nevertheless consumes an enormous amount of time, and reduces very materially the strength of the patient. In my opinion, surgeons have exaggerated the difficulties in the way of discovering wounds, which have made this procedure necessary. The incision over the course of the ball will aid materially in the diagnosis by exclusion, for no intestine which cannot be brought into the path of the missile could possibly have been hit by it. It is not probable that a gut would slip more than 3 or 4 inches away from the place it occupied when wounded, and with the incision I have mentioned the necessity would rarely occur of examining any other viscera than those in the immediate neighbourhood of the wound. Let us suppose that a surgeon in operating has repaired all the wounds he has been able to find in or near the course of the ball; he has washed out the abdominal cavity; he has with his hands gently pressed upon all the viscera which could possibly have been injured, and his hands have come out unstained; he has, furthermore, with soft sponges, wiped out the lower part of the abdominal cavity without finding blood or fæces. Shall he then, without any evidence whatever of an additional wound, subject his already exhausted patient to a most dangerous procedure on the mere suspicion that there might be a still undiscovered wound?"

It will be seen that the diversity of opinion as to the site of the incision, and the desirability of turning out all the intestines for examination, turns on the question of how best all injuries of the peritonæal cavity can be detected. The advocates of the latter step and the median free incision claim that by this alone can the needful inspection be made of all the viscera, both free and fixed, hollow and solid; they point to numerous cases in which even by this means of complete examination injuries have been overlooked and have marred the success of an otherwise complete and most hopeful operation; they hold that the median incision alone will meet those cases where the course of the ball is not direct, but erratic, or where, by moving the patient a long distance, or from peritonitis setting in late, peristalsis has altered the position of the bowels. Till we have more cases to guide us, I think the published evidence shows clearly that the median incision is the wiser save in a few cases, as where the wounds lie well away to one side, as here the colon may be found shot through, and only this organ and the contiguous small intestine and the kidney behind will require examination. It must not be forgotten that with the great advantage of more complete exploration which the median incision affords goes the greater risk of shock and of general contamination of the peritonæal cavity, as coils which are possibly leaking are drawn up into the wound. This will have to be met by careful irrigation later. With regard to turning out all the intestines, the advocates of this step claim that by this alone can all the wounds be found, and that this step, by the more rapid searching which it allows, in reality diminishes shock. Till more cases have been published—and surgeons owe a great debt to the candour and fulness with which the American surgeons have made known their failures as well as their successes—each case must be decided on its merits. The points which will aid the surgeon in coming to a decision on the above two steps are any obliquity of the wound of entrance and of the course of the ball; the position of the wound of entrance, whether near the middle or the lateral parts of the abdomen; any evidence of its having passed from side to side; entire uncertainty as to its course; the time that has elapsed since the injury; the interval between this and the last meal, and whether the patient has been kept quiet.

The chief points in the after-treatment are rectal feeding for forty-eight hours or longer if the stomach or upper part of the intestine have been injured.* Periodic emptying of the drainage-tube with a syringe, or even irrigation through it. Morphia injections, combined with atropia (about $\frac{1}{60}$ gr.) rather than opium. Cold to the abdomen by means of an ice coil. Careful use of saline aperients, *e.g.*, Seidlitz powders, as recommended by Mr. Tait, a little later.

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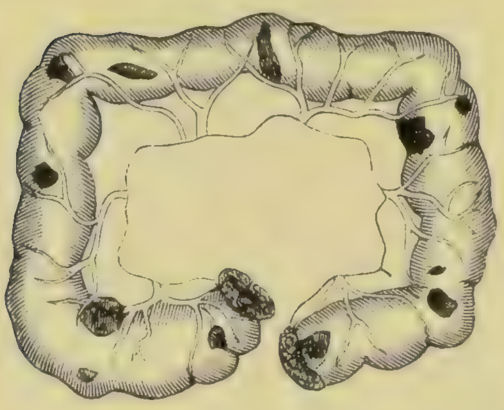
* The passage of a long tube may bring about the escape of flatus, and so give great relief.

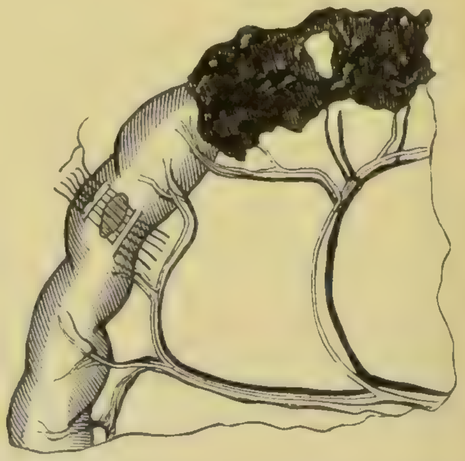
The following details are the outcome of experiments by Dr. Parkes.* They have already laid foundations for much good work. "Where several wounds occurred rather close together, and were enough to destroy a considerable portion of the integrity of the bowel, one resection was made to include all of them, even when the length removed measured 10 inches or more. Where the points of injury were widely separated from each other, and extensive damage done at each point, several resections of a length of the tube just sufficient to include the injured portions were made.† In the former case, in which several inches of the tube were taken away, the mesentery was ligated as close as practicable to the intestine (Fig. 128) in sections corresponding to the number of vessels going to the resected portions. The mesentery was then divided close to the intestine, and a V-shaped portion of it removed. After this the tube itself was divided and the wounded portion

FIG. 125.



Multiple bullet wounds (ten complete perforations) in 18 inches of ileum. A good instance of a class of cases most difficult to manage, and fatal in their results. (Parkes.)

FIG. 126.



To the left a bullet wound is shown pared, with six Lembert's sutures in position ready for tying. To the right the entire circumference of the bowel is shown, so mangled as to require resection. (Parkes.)

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* *Gunshot Wounds of the Small Intestines.* Chicago: 1884. Dogs were the patients.

† It seems probable that the greatest success will follow a single resection, even if that include a number of perforations, and involve 8 or 10 inches of the gut, in comparison with those cases where several excisions are made of wounded parts widely separated.

removed. One artery always needing ligation was found in the divided ends at the point of junction of the mesentery with the intestine. Before the final division of the intestine, its contents were pushed out of the way, compression being exercised on its walls by forceps or temporary ligature* (pp. 785, 798, Fig. 124).

"Results soon demonstrated the paramount necessity of carefully selecting the place for final division of the intestine, in order to avoid sloughing of the edges, the results being best in those cases where the division was made close to the point at which any given mesenteric artery approached nearest to the intestine, as compared with those where the cut was made in the intervals between any two branches, and this was seemingly dependent on the better supply of blood. Immediately after division of the intestine, there followed a regular and considerable contraction of the calibre of the tube close up to the divided edge, caused by the contraction of the circular muscular fibre. This persisted for a time, but was soon followed by an eversion of the mucous membrane, which rolled out and over the constricted portion in a remarkable manner (Figs. 125, 127, 128). This protrusion forms a serious obstacle to easy and close approximation of the ends of the bowel; and when turned into the bowel, diminishes its calibre considerably, although it was not demonstrated that the obstruction was ever sufficient to prevent the passage of the intestinal contents. Several attempts were made to get rid of it, but all these were finally abandoned.†

"In all instances where a perforation was severe enough to require a resection of the wounded part, it was found advantageous to leave, if possible, a strip of the bowel near the mesenteric junction (Fig. 127), taking out the wounded portion by a **V**-shaped incision. The part left acted as a support to the wound, avoided division of the blood-vessels, opposed the action of the longitudinal fibres, and in no instance in which this plan was adopted was there any appearance of separation of the wound.‡

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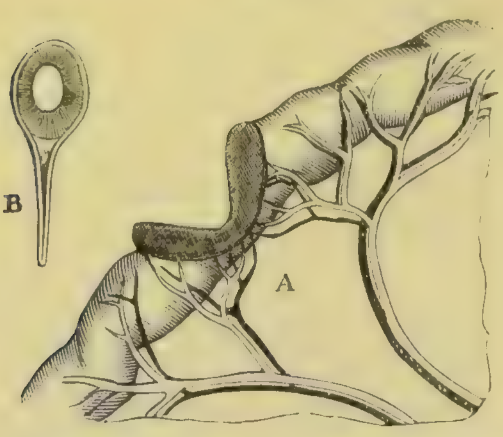
* The constriction mark made by the forceps or ligature was to be plainly seen several days after the operation.

† Thus "it was pared away with scissors; it was dissected up from the other coats for ¼ inch from the edges; but the conclusion was finally reached that, instead of being a harm, its presence was useful in giving support, protection, and, perhaps, vascularity to the freshly sutured edges; at least, in all instances where it was removed the stitches were found torn out and union defeated; in no instance where it was left entire did there fail to be union in some part, and no sutures gave way when properly applied."

‡ Dr. Parkes found that, in small perforations of the stomach and intestine, the case did well after drawing the peritonæal surfaces some distance from the

. . . . Perforations through the mesenteric surface of the intestine were the most difficult to treat, and, even if slight, seemed always to require a complete excision. A partial excision of this surface of the bowel resulted in an acute-angled elbow which never did well. The point of attachment of the mesentery with the bowel will usually be found the most troublesome to manage in applying the sutures in restoring a complete division. . . . . The difficulty arises apparently from the manner in which the folds of peritonæum separate from each other before passing on to invest the bowel, leaving a little triangular interval filled with loose connective tissue, fat, and vessels. Now, if the suture fails to include the muscular coat as well as the peritonæum at this point, the junction will surely give way. To make this point secure, the greatest care must be taken in placing at least three sutures, this number being usually quite enough to include the troublesome area, and these should always be the first sutures applied. In completing the junction, it assists materially, and especially avoids trouble from the everted mucous membrane, to apply one at the most convex surface, and then one half-way down on each lateral surface. . . . . The greatest number of mishaps followed drawing the sutures too tightly, which, if done, leads to death of the applied edges and of course to failure. They must be drawn only sufficiently close to bring the surfaces fairly in contact; the subsequent swelling from obstructed circulation will hold the surfaces firmly together until glued to each other by the rapidly forming adhesive material."* With regard to the best way of disposing of the divided mesentery after removal of some length of intestine, Dr. Parkes does not seem to

FIG. 127.



A shows the strip of bowel left at the mesenteric border (p. 803); B, the triangular interval where the mesentery encloses the gut, a spot very hard to close. (Parkes.)

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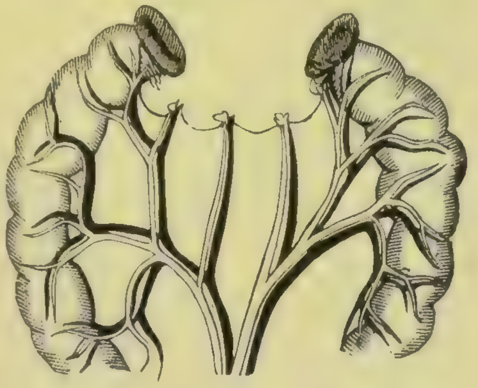
edges thereof over it by a continued suture, thus converting it into a linear wound. He thinks this plan may safely take the place of excision in not a few cases of quite severe injury.

* The sutures were of No. 1 catgut or No. 2 silk; fully curved round needles are recommended, or, preferably, ordinary straight sewing-needles. The method used was the continuous or Lembert's (Figs. 122, 123). Great stress is laid on not allowing the needle to enter the cavity of the intestine, lest the sutures and their track become septic, as shown by Mr. Howse in gastrostomy.

be decided. It would seem from his account, which is not clear on this point, that, after tying the mesenteric vessels (Fig. 128) and suturing the divided ends of the intestine, the cut mesentery should be united to the now joined intestine, making as nearly as possible a continuous surface of mesentery.

FIG. 128.



(Parkes.)

I append the following as instances of what injuries the surgeon may expect to have to deal with. Bullet wound near umbilicus; seven openings in alimentary canal—viz., three openings close together in the small intestine ($3\frac{1}{4}$ feet below the duodenum), two openings in the descending colon, and two in the rectum; no great extravasation; also a large vein wound in the mesentery; death from peritonitis; bullet found near ischial spine (Annandale, *Lancet*, April 15, 1885). Pistol wound near navel; seventeen hours later, operation; 2 pints of bloody serum let out, with small clots, but no fæces; seven penetrating wounds of intestine, six in the small, one in the sigmoid containing the bullet; all the openings plugged with ragged, everted mucous membrane; no fæcal escape till edges were separated; careful suturing and toilet; recovery after a very critical condition for a week (Bull, *Ann. of Surg.*, May 1885). Bullet entrance close to navel; operation two hours later; abdominal cavity full of blood; spirting artery in mesentery; eleven wounds requiring suture in small intestine, and two in ascending colon; no fæcal extravasation, but a melon-seed body found and removed; on the thirteenth day great rectal tenesmus led to discovery of blood effusion in pelvis; 3 pints let out by incision about 2 inches within anus; recovery; bullet passed per anum (Hamilton, *Journ. Amer. Med. Assoc.*, August 22, 1885; *Ann. of Surg.*, November 1885). Bullet entrance $3\frac{1}{2}$ inches above umbilicus, and just to left of middle line; operation within twenty-four hours; rent in omentum close to great curvature of stomach, and two linear rents in this viscus found with much difficulty; operation had to be concluded quickly from patient's critical condition; death within a few hours with acute peritonitis; four wounds found in upper part of jejunum, all within a distance of 3 inches (Briddon, New York Surg. Soc., December 8, 1886; *Ann. of Surg.*, April 1887). Bullet wound 2 inches above and 2 inches inside right anterior superior spine; operation in nine hours; wound found in ascending colon pouring out fæces; another wound in colon also pouring out fæces; both sutured; recovery (McGraw, *Chicago Med. Journ. and Exam.*, July 1887; *Ann. of Surg.*, December 1887).

A very complete table, containing 234 cases, is given by Dr. T. S. K. Morton (*Journ. Amer. Med. Assoc.*, Jan. 4, 1890); others by Sir W. MacCormac and Mr. Barker will be found in the *Brit. Med. Journ.*, May 11, 1887, and March 17, 1888.

RUPTURE OF THE INTESTINE.

The following remarks are taken from the Cartwright Prize Essay by Dr. B. F. Curtis, of New York (*Amer. Journ. Med. Sci.*, Oct. 1887:—*Relative frequency of rupture*, in 113 cases.—Duodenum, 6; jejunum, 44; ileum, 38; "other parts of small intestine," 21; large intestine, 4. While the duodenum and large intestine escape from their sheltered position, the jejunum is most frequently ruptured in its first 3 feet, the ileum in its last 3. Fæcal extravasation is almost invariably present. The most frequent and important complication of ruptured intestine is laceration or contusion of the mesentery; this is important from the rapidly fatal hæmorrhage, or, later, gangrene. The cases of ruptured intestine fall clinically into three classes. (A) The shock never leaves the patient, may never lessen, but pass, rapidly or slowly, into fatal collapse. This may be due to (1) the shock of the accident; (2) to hæmorrhage; (3) to fæcal extravasation. (B) Those in which evident peritonitis developes. The diagnosis is easiest in these cases, but unfortunately they are not the most common. (C) The most common. Instead of evident peritonitis setting in after reaction has taken place, vague symptoms appear, keeping the surgeon in expectation of it, but giving nothing on which he can found a positive diagnosis, for the same slight indications are common in cases in which ultimate recovery has taken place. Patient is apathetic, seemingly satisfied with his condition, and thus misleading; or, getting gradually weaker and, therefore, being less able to complain, appears to be improving. Peritonitis in this group of cases developes so slowly that its beginning cannot be noted. *Duration of life.*—The average taken from 113 cases is forty-eight hours. *Chief points in the diagnosis of rupture of intestine.*—Cause—*e.g.*, a kick. This was so in 28 per cent. of the cases. The intestine is crushed between the spine and the force employed. Severe shock,* pain, tenderness, vomiting,† tympanitis,‡ and peritonitis. A certain diagnosis is seldom possible for the first sixteen hours, and symptoms may be latent longer. There may be evidence of hæmorrhage from laceration of liver, mesentery, or kidney. The symptoms of contusion only are often more acute at first than those of rupture, but generally the patient soon begins to improve. *Treatment.*—Where rupture of intestine or severe hæmorrhage is probably present, exploration should take place at once, but in the severest contusions there are many chances that the intestine has escaped. The incision should be median and a long one, at least 4 inches, the parietes here being normal, not distended and atrophied as in abdominal tumours. When all the intestine has to be drawn out and examined, and no operation can be otherwise complete, the incision should be 8 inches long. In any case the centre should be at the umbilicus, unless it is clear that it is the stomach that is injured. It should not be lower down, or the attachment of the mesentery may interfere with the pulling out of the intestine, especially if it be short and thickened with fat. Blood may show through the peritonæum before this is opened. When this membrane is incised, a sponge should be passed in on clamp-forceps to search for blood, fæces, or pus. If hæmorrhage is going on, the opening the abdomen may stop it (Parkes, *Med. News*, May 17, 1884), or it may increase, causing grave symptoms. If it well up, a hand should be passed in, under the omentum, upwards and backwards, to make pressure on the abdominal aorta and root of the mesentery. All the small intestine is then turned out into hot aseptic towels, bleeding points are then found and secured with clamp-forceps, while the pressure is relaxed to note the effect on the bleeding. The bleeding being arrested, any injury to the intestine is sought for. If a rupture is found, the part should be kept outside in a hot aseptic towel, while the rest is returned. If hæmorrhage is slight or absent, the intestine should be drawn out loop by loop, and inspected till the whole is examined. Fæcal extravasation should be avoided by extremely careful handling of the intestine,

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[*] Shock is quite unreliable, as it depends, not on the severity of the injury, but on the idiosyncrasy of the patient.

[†] This is usually persistent when rupture of the intestine is present.

[‡] Mr. Robson (*Clin. Soc. Trans.*, vol. xxi. p. 130) thus lays stress on the liver dulness. When normal, this is almost proof of absence of perforating wound of alimentary canal; when diminished it is suspicious, but when absent it is almost pathognomonic of ruptured intestine.

the wound thus remaining unsoiled. When all the intestine is inspected, the peritonæal cavity should be carefully flushed out as at p. 775. Any distended coil may be aspirated and the puncture tied up or opened as at p. 773. If the large intestine be much distended, a long rectal tube may be passed and manipulated along through the walls of the intestine. Small ruptures will often admit of suture without resection. In most cases of rupture of the intestine, making an artificial anus will be the best course, the continuity of the gut being restored later. Resection and suture should be reserved for the most favourable cases. If the case is very grave, the best course is to make an artificial anus by closing the ends of the intestine with ligatures or clamps, then to thoroughly cleanse the peritonæal cavity, next pass the parietal deep sutures farther back than usual, so as to thoroughly evert the peritonæum, and trust to the presence of these sutures, together with the ligature or clamps, to hold the ends of the intestine in place until the adhesions are firm. This course ought not to take more than half an hour. Other viscera may be injured and have to be dealt with (*vide supra*, p. 797). No operation should be performed if marked collapse is present. If the patient does not respond to stimuli, he will not survive laparotomy.

Mr. Robson (*loc. supra cit.*) advises as follows on the question of operation :—" In cases of doubt one is so prone to wait, hoping for the turn of events, and then to arrange to operate when too late, that it is well to have some formulated rule, and for my own guidance I have adopted the following. In cases where there is a reasonable belief that the intestine is wounded, exploration by a small median incision must be made, when, if there is any rupture of the bowel, flatus, or serum tinged with blood, or feculent material will escape through the small peritonæal opening, which can then be enlarged and necessary treatment adopted ; but should no flatus or fluid appear and the peritonæum prove to be healthy, the small wound can be closed."

CHAPTER VII.

OPERATIONS ON THE STOMACH.

GASTROSTOMY. — GASTROTOMY. — DIGITAL DILATATION OF PYLORUS.—EXCISION OF PYLORUS.—CURETTING CANCER OF STOMACH.—GASTRO-ENTEROSTOMY—DUODENOSTOMY AND JEJUNOSTOMY.

GASTROSTOMY.

Indications.

1. Certain cases of cancerous stricture. This also includes invasion of the œsophagus, secondarily, from primary cancer of the mediastinal glands, &c. 2. Cancerous disease of the pharynx; and, in a few cases, malignant disease of tonsil or back of tongue not admitting of operation. A very interesting case is given by Mr. Whitehead (*Brit. Med. Journ.*, July 22, 1882). Here, in a patient aged forty, excision of the tongue had to be followed by tracheotomy and gastrostomy, owing to the original extent of the disease. At the last report the patient was alive, four months after the gastrostomy, five after the removal of the tongue. Two such cases are given by Mr. Stonham (*Lancet*, Oct. 2, 1886). One patient survived four months; the other, one. In this case the growth was so extensive as to necessitate tracheotomy at an early stage of the gastrostomy. Both patients experienced great relief. Tracheotomy was also required in Mr. King Green's case (*Lancet*, Feb. 3, 1883), though here the disease was either in the pharynx or upper part of the œsophagus. I think that in these cases, also, the last few months of life might often be rendered much more comfortable by a timely performed gastrostomy. 3. Cicatricial stricture, whether traumatic or syphilitic.

The first of these, from its frequency, requires separate notice.

1. Cancerous Stricture.—Here several points call for attention. Amongst the chief are—the question of the treatment of œsophageal cancer by passage of tubes or gastrostomy; the mortality of the latter operation; and the best date for performing it.

Between treatment by gastrostomy and that by tubes no fair comparison can be made, because the former operation has, in such a large number of cases, been performed under most unfavourable conditions. Much too often it has been put off till the patient, scarcely able to swallow liquids, is just kept alive by enemata. Such patients, worn out by the miseries of slow starvation, often with secondary disease and lung and pleural trouble, are not in a condition to be submitted to abdominal section, and are not likely to respond to the call made upon their vitality to unite two serous surfaces firmly together, on which depends the success of the operation.* I do not think that I exaggerate if I say that, in a distinct proportion of the cases in which the surgeon is asked to perform gastrostomy, the hand of death is already on the patient, and something next door to the decomposition of the grave has already set in, owing to the extension of the disease.

In advising gastrostomy, each case must be decided on its merits; the patients here are not only adults, but well on in life, and, when assured that the end is certain, the surgeon may, in most cases, having put all the risks before the patient, leave it to him to decide. But I think that if the patient, having previously declined it, only asks for operation when it is clearly too late, the surgeon should be firm enough to decline to operate where, on every ground, his interference will be hopeless.

The following points help in a decision between gastrostomy and tubage:—

i. Food taken.—As long as pulpy, semi-solid, or even a proportion of solid food is taken, tubage should be persevered with. But when the time comes that the patient is becoming restricted to liquids, the hour for a successful gastrostomy is slipping by. When the patient is fed by enemata only, and merely takes ice by the mouth, it is too late to operate.

ii. Amount of pain felt with and difficulty in passing bougies or tubes.—Any sensation of a rough raw surface, any blood or broken-down tissue on the bougie, increased expectoration, dyspnœa, paroxysmal cough (this may occur after even a teaspoonful of fluids), fœtor of sputum or bougie, make it evident that the passage of instruments causes advance of ulceration and sloughing; when this is increasingly accompanied with pain and evidence of laryngeal irritation, gastrostomy should be proposed.

iii. Site of stricture.—The lower down this is, the more difficulty will there usually be in dealing with it by dilatation, and the nearer are important parts.

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* Such statistics as those of M. Blum (*Arch. Gén. de Méd.*, Nov. 1882) require revision now.

iv. Condition of patient.—Here the rate of emaciation must be watched—anything like a loss of 1 to 2 lbs. a week is very ominous. How far is the strength preserved ? how far does the patient tend to give up his life-habits ? how far is he bedridden ? Where the pulse is thready, the extremities cold, the temperature never up to normal, the case has gone too far.

v. Condition of viscera.—Evidence of implication of trachea or bronchi, of pleuritic effusion, and of broncho-pneumonia must be sought for. If there is reason to believe that the growth has extended beyond the œsophagus, operation should usually be declined.

vi. Rank of life.—A patient who can afford all the luxuries of life, and who can have everything done to palliate his condition, is, obviously, in a very different condition to one in a humbler position.

I would thus sum up this question of gastrostomy or treatment by tubes:—As long as a patient can swallow solids or semi-solids, treatment by tubes and bougies should be persevered with. Whenever they can be introduced, the tubes ingeniously devised by Mr. Symonds* will be preferred. These have a funnel-shaped extremity resting on the upper end of the stricture, are introduced by a conical bougie, and are kept *in situ* by a loop of silk, which comes out of the mouth and is looped round the ear. They are not unsightly, have the great advantage of allowing the patient to swallow his saliva and food, and thus retain the pleasures of taste.

If a larger pattern of bougie is needed, none is more suitable than the flattened bulbous one, ending in a conical point, of Mr. Durham.*

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* *Clin. Soc. Trans.*, vols. xviii. p. 155, xxii. p. 306 ; *Brit. Med. Journ.*, April 23, 1887. See also Dr. Rodman's two cases, *Brit. Med. Journ.*, May 25, 1889. It is clear from these cases that patients can be kept alive as long and gain weight equally by tubage as by gastrostomy, and that in some cases even a malignant stricture can be dilated. On the other hand, the passage of tubes, where there is considerable narrowing, clearly requires some force, and thus needs skilled and veiy careful hands. Even in such hands, fatal mischief has been inflicted. Furthermore, the blocking of the smaller tubes which alone will pass in the later stages will necessitate frequent changing. With the results above given, Dr. Rodman thinks that if the eye of the tube be terminal, or, if lateral, if the tube be not perforated to the slightest degree below the eye, there will be less risk of clotting of casein and obstruction of the tube. But neither these precautions nor passing a little water down the tube after each feeding will prevent a block of these smaller tubes, which alone can be passed throught tight, tubular, and ulcerating strictures.

Any surgeon treating cancerous stricture here by dilatation must remember that treatment of cancer in this way is contrary to what is generally practised, and is only justifiable here on special grounds—*e.g.*, the fatality of the disease and the risks of gastrostomy; that these risks have been enormously increased by the way in which this operation has been deferred; that there comes a time in these cases when tubes can no longer be made use of; and that if gastrostomy has been deferred till now it had better not be performed at all. In other words, the patient should understand that if he shuns the risks of an early operation, he renders himself liable to other but as serious risks by deferring it till an hour when he can only ask for it, and the surgeon only attempt it, as an almost utterly forlorn hope.

The question of which gives the greatest comfort cannot be answered dogmatically. But no one who has seen many cases of gastrostomy, and met with a fair proportion of success, will hesitate to prefer the result of this, if performed early, with its gain of weight and freedom from pain and irritation during the few months which in any case remain, to the passage of tubes necessarily more and more frequent and difficult as the case progresses, with the not infrequent distress and choking when they are introduced, the blockage of the hollow ones by sputum or food, and the needful withdrawal and re-introduction, easily effected, no doubt, for some time, but ever irritating and fretting the growth.

I have performed gastrostomy nine times, in each case for cancer of the œsophagus: in three patients the operation was asked for too late; in one, my seventh case, the patient died from an accident, for which I am responsible (foot-note, p. 816); the other five recovered well. One, a young married woman, had had symptoms six months; she was in the fourth month of pregnancy when operated on; she lived in comfort for six months, and died, a month after giving birth to a child at the full time, of extension to the lung. Another patient lived between three and four months, and would have survived longer if it had not been for his carelessness as to exposure. A third was alive and progressing satisfactorily when last heard of four months after the operation. The fourth is still alive, four months after his operation. The fifth has made a good recovery, but only nine weeks have elapsed since the operation.

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* *Syst. of Surg.*, vol. i. p. 798. The bougies are made by Kröhne and Hawksley.

Operation (Fig. 129).—Method of Howse[*] by Two Stages. *First Stage.*—Those precautions being taken against shock, such as warm wraps, hot bottles, ether as an anæsthetic if the condition of the lungs admits of it, and if it is quietly taken without troublesome, heaving breathing, the surgeon will usually find it most convenient to stand on the right side and to have his patient drawn over to this side of the table. The shoulders should be somewhat raised and the hips slightly flexed, to relax as much as possible the tension of the soft parts, which often fall with embarrassing sharpness over the epigastric angle from the prominent ribs down to the wasted, retracted umbilical region.

Mr. Howse (*Dict. Pract. Surg.*, p. 590) recommends the following incision :—(1) An oblique one, about 2½ inches long, parallel with and about 1 inch below the lower margin of the left costal cartilages. This incision should start about 1½ inch from the middle line, and its length must depend on the varying development of the rectus muscle. It should not go higher than the above point, as it will not leave enough free skin and muscle between the cartilages and the incision to fasten the sutures to. This first incision is only to be carried through the skin and fascia. When made, the sheath of the rectus will be seen at the inner end, and at its outer end a portion of the linea semilunaris and of the external oblique. The usual plan of continuing the operation is to have the muscles and fasciæ of the abdomen incised in the same way as the superficial parts. Mr. Howse prefers to continue the operation as follows :—(2) The lips of the wound being separated towards the inner part as widely as possible by retractors, a vertical incision is made in the sheath of the rectus a little from its outer margin. The vertical fibres of this muscle will then be seen, and these should be separated, not cut, with the handle of the scalpel, and the posterior part of the sheath exposed. This may then be incised vertically.

From my experience of nine cases I prefer, as simpler, a single vertical incision (Fig. 129) beginning opposite to the end of the eighth intercostal space and passing down for 3 inches over the rectus—*i.e.*, about 2 inches from the linea alba. The fibres of the rectus, being exposed, are torn straight through with a steel director, and the posterior, somewhat concave layer of its sheath exposed. This is carefully divided for the full length of the incision, and the extra-peritonæal fat (if present) and the peritonæum picked up and opened together. A finger is now introduced (Fig. 129) to feel for the stomach.* All irrigation should be stopped before the peritonæum is opened, and every care taken that everything brought in contact with the wound is strictly aseptic.

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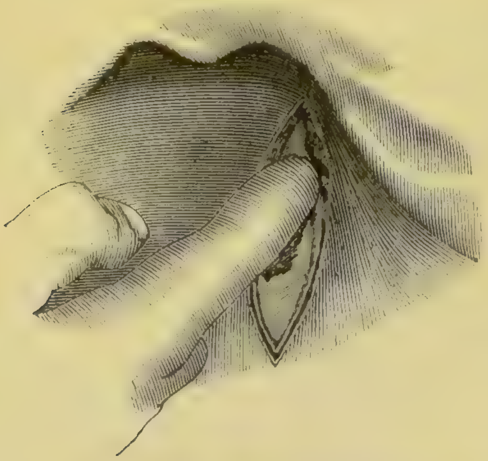
[*] Mr. Greig Smith (*Abdom. Surg.*, p. 302) states that the plan of operating in two stages was originally suggested by Egebert, a Norwegian surgeon (1841), and also advised by Nélaton. It is to Mr. Howse's practice, however, that we owe our knowledge that this operation is safe if performed in two stages, with strict antiseptic precautions, and when not too long deferred.

FIG. 129.



The finger searching for the stomach through a vertical incision.

As a rule, the contracted stomach lies high up under the left lobe of the liver, and requires to be hooked downwards and forwards into the wound. Not unfrequently the great omentum presents first, and it is easy, by seeking too low down, to draw up the colon. In case of difficulty the best plan is to find the anterior border of the liver, trace up the under surface to the portal fissure, and thence along the lesser omentum to the stomach. This is told by its thicker, more substantial feel and pink-red colour.

The stomach being drawn up, a part is chosen on its anterior surface, free from vessels, and as near as possible to the cardiac end.

The stomach is next fixed to the edges of the wound with sutures of carbolized silk and wire. Mr. Howse thus ties his chief sutures over bits of bougie:—" Drawing the stomach well over to one side, a needle (in handle) carrying the silk should be passed through the serous and muscular coats of the stomach only, and should then transfix the abdominal parietes about 1 inch from the wound. The needle is now withdrawn, leaving one end of the silk on the surface, and, without unthreading the other end, the abdominal parietes are again punctured alone. The needle is now unthreaded and withdrawn. The two ends of silk will thus be left projecting from two distinct wounds on the skin, close by one another, and holding up a bit of the serous and muscular coats of the stomach. Before tying any one suture it is best to introduce the others, drawing the stomach well over from the side towards which it is wished to introduce the suture. Six or eight sutures introduced in this fashion are usually used. The result is to fix the gastric peritonæum in a circle about 1 inch round the wound. The part of the stomach exposed in the wound should then be fixed to the lips of the incision by small wire sutures, introduced by a small curved needle held in a needle-holder, these again only taking up the serous and muscular coats of the stomach."

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* While the finger feels for the stomach, it also examines for any enlarged glands.

In my cases I have dispensed with the above, using many (five or six on each side, and one or two at each angle) sutures of fine carbolized silk in the ordinary way, but passed with strict attention to the directions given below. By some, hare-lip pins* have been used. I advise in any case, to ensure apposition of the peritonæal surfaces, that the parietal peritonæum be first sutured to the edges of the wound. In some cases Mr. Howse has dispensed with sutures, keeping the stomach *in situ* with torsion-forceps protected with drainage-tube. Save in very urgent cases, I think careful suturing is much to be preferred.

The additional time spent in careful stitching will well repay the operator. However the sutures are inserted, the following points, on which Mr. Howse in introducing his operation laid much stress, should be carefully attended to:—(α) To make the needle travel for a sufficient distance in the muscular coat in taking up the stomach. (β) Not to include or puncture the mucous coat, for fear of causing septic fistulæ. (γ) To bring the needle through the parietes quite an inch from the edges of the wound. (δ) In doing so, to include the parietal peritonæum. (ϵ) To bring up a circle of stomach a full inch in diameter.

When the stomach is secured—and the sooner it is to be opened, the more carefully must the stitching be carried out—a suggestion, I believe, of Mr. Bryant's should be followed, and a fine suture of silk or catgut introduced in the centre to guide the surgeon, in a few days, to a safe site of puncture (*vide infra*). The upper and lower angles of the wound are next closed with carbolized salmon-gut.

Free as the wound has seemed before, it is now markedly puckered up. A little iodoform is dusted on, a piece of protective smeared with carbolic oil applied, and then dry sal-alembroth gauze dressings and wool, with a many-tailed bandage.

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* *Lancet*, February 20, 1886; *Brit. Med. Journ.*, December 6, 1884. The pins, if used, must be very fine ones, or gastric fistulæ, or gangrene and abscesses as in Schoenborn's case, may result. Mr. Chavasse in the first of the above papers figures "a running or gather stitch." This is simple in its application and effectual, but it would seem likely so to close the wound as to render the second stage difficult. This method and pins have the advantage of rapidity.

When in bed the position of the patient must be such as to relax the parts. A little morphia should be given subcutaneously, whenever not contra-indicated; great attention paid to keeping the patient warm, and nutrient enemata, followed by one of Burroughs & Wellcome's nutrient suppositories, given every three, four, or six hours.*

Second Stage.—This in all cases admitting of delay should be deferred till the third, fourth, or fifth† day, so as to give time for firm adhesions to form between the two surfaces, and thus to soundly shut off the general peritonæal cavity. No previous change of dressing will probably have been required. The wound is now found still more puckered, its edges inverted somewhat, and almost in apposition save for the strips of gauze which have been inserted. The stomach surface is no longer recognizable as such, being coated with lymph, this showing the importance of a guiding suture. Close to this the stomach wall is punctured by a quick stab with a very sharp tenotomy knife, the wall being raised and steadied by the loop. A piece of No. 7 gum-elastic catheter is then slipped in as the knife is withdrawn.‡ A bit of tubing and a small funnel having been attached to the end of the catheter, a few drachms of milk and brandy are thus quickly given. The tube is then tied with silk or plugged, and left projecting amongst some strips of dry gauze which cover the wound. Collodion and iodoform are an excellent application after the fourth or fifth day. Larger catheters are soon introduced, and then india-rubber tubes large enough to admit of finely minced solids in a pultaceous form.

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* Thirst may be relieved by glycerine and iced water as a mouth and throat wash, and occasional enemata of warm water.

† Mr. Howse has usually adopted this date. In one case (Sir W. MacCormac, *Brit. Med. Journ.*, August 2, 1884) the performance of the second stage was deferred for seven weeks, some power of swallowing having returned. A guiding stitch had been left in.

‡ This sounds simple enough, but it is by no means always easy to feel certain that the stomach has been opened. This is due to the puckered contraction of the wound and alteration of its surface, the stomach coat being thus no longer recognizable, and to its lying much deeper than would be expected, making "the operator sometimes fear that he has punctured the lesser bag of the peritonæum" (Howse). In one case, my seventh, though I thought I had punctured the stomach directly and sufficiently, it was not so. The patient dying two days after, peritonitis and fluid food in the abdominal cavity were found. The puncture and catheter had both run obliquely through the stomach wall, and communicated with the cavity of this viscus and that of the peritonæum as well.

For the first few days milk and brandy, just warmed, and peptonized if preferred, should be the chief food given with the yolks of one or two eggs. A little later beef-tea, soups, well-pulped vegetables, with plenty of fluid, should be given. In Mr. Howse's words, "When the larger sizes of tubes have been introduced, solid food may be poured into the stomach by the aid of a large wide-mouthed syringe. This food should be minced meat, with a certain proportion of vegetables, all finely ground in the mincing machine."

Patients are often very ingenious in feeding themselves. Some, to enjoy the taste of food, have masticated solids and then passed them through the fistula.*

If the operation has been deferred till too late, and it is absolutely needful to feed the patient at once, the safest method will probably be to introduce, every few hours, a small amount of liquid through one of the large hypodermic syringes made for exploration, and holding a drachm or two. The puncture must be repeated at each occasion of feeding. In these cases especial care must be taken in the suturing the stomach, and, if this is opened at once and a tube introduced, every precaution must be taken to go through the mucous membrane, and not to detach this or to loosen the sutures. If a catheter or tube is introduced at once, it must be a fine one, otherwise escape of secretions will render the wound aseptic, and the result a fatal one.

Difficulties in and after Gastrostomy.

i. The very prominent angle formed between the ribs and the sunken umbilical region (p. 813). ii. Hæmorrhage. This will be almost *nil* if the rectus fibres are separated with a director, and the veins on the stomach carefully avoided. iii. Finding the stomach. iv. Drawing this up into the wound if itself affected by disease, as when the primary disease is situated very low down in the œsophagus, or if it is adherent by reason of secondary deposits. v. Jerking breathing due to the anæsthetic. vi. Completing the second stage of the operation. vii. Intense pain on introducing food into the stomach. In a patient of Mr. Butlin's (*Brit. Med. Journ.*, April 14, 1883) this was found to be the case, the patient dying nearly a month after the operation. Mr. Butlin attributes this pain to his opening having been close to the pylorus.† If it is thought that the opening is made too near either extremity of the stomach, it would be well after feeding to keep the patient turned on to the opposite side. viii. Leakage of gastric juice and regurgitation of food. This is an extremely troublesome complication, leading, as it does, to most rebellious eczema and erysipelas. It is best prevented by making as small a wound as possible in the abdominal walls, going through the rectus muscle, and opening the stomach by a mere puncture. If, in spite of these precautions, leakage still takes place, leaving out the tube for a few hours at a time will allow of some recontraction. The patient should also be kept as flat as possible after feeding. Regurgitation of food is often due to the stomach being opened too near to the pylorus.

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* Thus, Mr. Durham (*Syst. of Surg.*, vol. i. p. 803; *Lond. Med. Rec.*, March 1878) mentions a patient of Trendelenburg's who, after masticating his food, spat it into a funnel, and then forced it on through a tube into his stomach. Two of my later patients have fed themselves after this fashion through a tube.

† Thus causing constant dragging on a fixed part. The middle, or cardiac end

In some cases of gastrostomy for non-malignant stricture the fistula has been subsequently closed. I did this in 1877, at Mr. Howse's request, in a most successful case of gastrostomy of his for œsophageal stenosis after swallowing a corrosive poison. Mr. Davies-Colley has published another equally favourable ending in a case in which the œsophageal mischief had been syphilitic (*Guy's Hosp. Reports*, 1884, vol. xxvii. p. 367).

Causes of Death after Gastrostomy.

1. Inanition and exhaustion, the operation being performed too late.

2. Peritonitis.

3. Extension of the disease to surrounding parts—*e.g.*, trachea, bronchi, &c.

4. Lung affections. Pneumonia is due in part to the operation—viz., the anæsthetic and the enforced recumbency. It is especially frequent in "too late" cases.

5. Hæmorrhage—*e.g.*, from ulceration into aorta or lung.

6. Acute gastritis.

7. Suppuration between stomach and liver, and due probably to irritation round one of the sutures.

GASTROTOMY.*

Indications.—These are very few, the majority of bodies swallowed passing through the pylorus. Of the few which will

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of the stomach should be opened, as being more movable and less likely to lead to rapid escape of the food. In a case of Mr. M'Carthy's (*Lancet*, 1887, vol. ii. p. 859) for the first few days severe pain was felt, after each feeding, in the left shoulder. This gradually disappeared.

* By this term is meant an incision into the stomach for the removal of foreign

call for operations, forks, as in MM. Labbé's and Péan's cases, and masses of hair, as in Mr. K. Thornton's (*Lancet*, January 9, 1886) patient, are good instances. Increasing pain, vomiting, emaciation, and sufficient time having elapsed to allow of the body passing will be the chief justifications of an operation. In a very few cases (p. 820) gastrotomy will be required to aid the removal of foreign bodies impacted low down in the œsophagus.

Operation.—A. For Removal of Bodies from the Stomach.—Such cases as Mr. Thornton's show that this operation can be safely performed at one stage.

The parts being cleansed and the abdomen relaxed, one of the following incisions is made:—(1) Over the body itself, when this can be felt. (2) In the case of a large body, in the middle line, from the xiphoid cartilage down to or below the umbilicus. (3) One of the incisions given for gastrostomy—*e.g.*, one parallel with the left costal margin and about an inch below it, reaching from a point near the xiphoid cartilage obliquely downwards and outwards to a point opposite to the ninth rib. One of the first two will probably be the best. The abdominal wall being divided, and the peritonæum opened as in gastrostomy (p. 813), the exact site of the foreign body is made out.* If this be pointed, great care must be taken not to let it damage the stomach during the needful manipulations. In such cases the external opening must be free, that the surgeon may see what he is about. In the case of such a body as a fork the blunt end must first be found.

When the surgeon has decided where to open the stomach, he brings this part out of the wound and packs sponges all around it, so as to steady it, and also to shut off the peritonæal cavity.

The stomach is now opened with scissors by an incision transverse to its long axis, and of length adapted to the case. As far as possible any vessels must be avoided, but any that spring will at once be commanded by Spencer Wells' forceps. The body is next extracted with suitable forceps or a scoop, care being now

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bodies, the opening being immediately afterwards closed, as opposed to "gastrostomy," the making of a more or less permanent fistulous opening.

* It has been proposed by some to facilitate finding the stomach by distending this with effervescing media, but, as Mr. Greig Smith points out, the disadvantages are serious—viz., trouble to the patient, liability of the distending medium to escape into the peritonæal cavity, and, lastly, the increased difficulty of finding the body in a distended stomach. In Mr. Thornton's case, the hair weighing 2 lb., greatly distended the stomach. It would probably be well in the case of a smaller body, to wash out the stomach beforehand with a dilute solution of boracic or salicylic acids.

taken not to damage the stomach, especially if the foreign body has set up inflammation or ulceration, and to allow no blood or mucus to escape into the peritonæal cavity.*

Before introducing the sutures, Mr. Thornton placed a carbolized sponge "to keep the edges in apposition for suture and to prevent accumulation of blood in the organ. Fifteen sutures of fine carbolized silk were then introduced through all the coats, the needle being slanted through the wall so as to come out just at the inner edge of the mucous membrane, which was much inclined to curl. The interrupted sutures were passed so as to control the cut vessels, and no ligatures were used. Another row of similar sutures was then passed between each of the deep sutures, but only through the peritonæum. The deep sutures entered the peritonæal coat about $\frac{1}{4}$ inch from the edge of the incision, and were $\frac{1}{3}$ inch apart; the superficial sutures were entered about the same distance from the edge, and ran along just under the peritonæum. When these were all in place the sponge was removed from the stomach, and they were tied, the deep first. These two rows caused some inversion of the peritonæum, and the two outer and upper edges of the peritonæal edges of the depression thus formed were brought together by a continuous suture of very fine carbolized silk. . . . . The closed wound measured exactly 3 inches."

Stomach feeding was only commenced forty-eight hours after the operation, a teaspoonful of iced water and milk being given every half-hour, the quantity being increased till the afternoon of the next day, when 2 oz. were given every hour. On the sixth day 3 oz. were given every two hours. On the fourteenth day corn-flour was added to the diet, on the fifteenth some crumbled bread, and gradually an ordinary light diet. During the first week 3 oz. of beef-tea were injected into the bowel every three hours, with 20 drops of laudanum every six hours. The patient made an excellent recovery, though Mr. Thornton had to remove a sponge from the abdomen the day after the operation.

B. For Removal of Bodies—*e.g.*, Tooth-plates—impacted in the Lower Part of the Œsophagus.—These cases, though rare, are so difficult as to call for some remarks here. Prof. Richardson, of Harvard University, first brought forward a very successful case of this operation (*Lancet*, 1887, vol. ii. p. 707). A plate carrying four teeth had been impacted eleven months in a patient aged thirty-seven. Numerous attempts had been made to remove it from the mouth. The plate was successfuly removed by gastrotomy, by an incision, 6 inches long, parallel to the lower margin of the left ribs. The following interesting details are given:—

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* Mr. Greig Smith (*loc. supra cit.*) writes: "When the foreign body has been removed, it may be wise, if there is much mucoid, purulent, or bloody material in the stomach, to cleanse it by means of small sponges on holders. The less the stomach is irritated the better, however."

Determination of the Site of the Foreign Body.—In an individual of average height, and with a neck of ordinary length, the distance from the incisors to the diaphragm is 14½ inches. All parts of the œsophagus are accessible to the finger either by gastrotomy or external œsophagotomy. With the right forefinger introduced by œsophagotomy and the left by gastrotomy, it was found possible, not only to make the fingers touch, but in many cases overlap. But these results are only approximate, as it would not always be possible to do both operations on a patient. It is possible to reach with the left hand 3 inches above the cardiac opening—*i.e.*, the length of the left middle finger. From above, through the wound in the neck, one cannot reach quite so far on account of the sternum and clavicle. Allowing in the average neck 1½ to 2 inches from the cricoid cartilage to the lowest point of the wound in the œsophagus, we have the average distance from that incision to the cardiac opening of 5½ or 6 inches. If the obstruction be less than 6 inches from the cricoid, an attempt should be made to remove it from above; if more than this, or 13 inches from the teeth, gastrotomy should be performed. The incision that, on the whole, is recommended is an oblique one below the margin of the left ribs. The stomach being drawn up into the wound, it is most essential to put the lesser curvature on the stretch, so that it makes a straight line to the diaphragmatic opening. The cut through the stomach wall must be far enough to the right to allow the passage of instruments along the sulcus between the anterior and posterior walls of the stomach, made tense as above. If the instrument is brought obliquely to this groove and passed upwards, all the time being pressed gently against the straightened lesser curvature, it will glide into the œsophagus every time with the greatest ease. The opening in the stomach should be first large enough to admit instruments; if these fail, it must be enlarged, and the whole hand introduced.

In the following case I was much less fortunate, owing to the way in which the tooth-plate was jammed above the cardiac orifice. While such cases are rare, they are most important, on account of the numerous difficulties which they present.

E. W., aged forty-four, was sent to me at Guy's in May 1889, having swallowed a vulcanite tooth-plate, which "stuck in his throat." The plate originally carried seven, but now only two teeth. A medical man whom he saw at once pushed the plate down with a bougie. An emetic which had been given then acted and brought up some blood. The patient complained of constant pain in the epigastric region, just below the xiphoid cartilage, and in his dorsal vertebræ. Swallowing was painful, and so was eructation of gas, though this gave relief. Patient was able to swallow food quite well. He was not troubled by vomiting. A bougie could be passed into the stomach, but just before it entered it rubbed over a foreign body. The body did not yield in the least to any force which I thought it justifiable to use with the bougie. June 11th I operated as follows:—The stomach having been washed out with dilute boracic acid, an incision 3½ inches long was made, parallel with the rectus, commencing on the level of the xiphoid, and about an inch to the left of it. The rectus, the sheath being opened, was split with a steel director. The stomach was very small and pale. Sponges having been packed around, it was opened, with scissors, just to the right of the cardiac end, and as high up as possible. The opening was about ¼ inch long. Three small vessels sprang, and were tied. The exploring finger detected the body imbedded just above the cardiac orifice. The mucous membrane around felt pulpy and swollen. Numerous curved forceps were introduced by the opening, and then along the lesser curvature, but, though the body was repeatedly seized, I was quite unable even to loosen it. This was due to its not presenting any projecting points and to the swelling of the mucous membrane around. I next enlarged the opening in the stomach so as to introduce my hand, but, though with the tip of the middle finger I was able to reach the plate, I was unable to dislodge it. Mr. Durham and Mr. Davies-Colley also tried, with a like result. Moreover, to steady it, Mr. Tubby was good enough to keep the end of an œsophageal bougie pressed against it from above. I closed the lower two-thirds of the wound in the stomach with Lembert's sutures of fine silk, and stitched the remaining part to the upper part of the parietal incision, so that other forceps might be tried later on. The patient, however, never rallied completely, and sank about forty-eight hours afterwards. At the post-mortem examination the coronary arteries were found in an advanced stage of atheroma. There was no peritonitis or escape of gastric contents. The mucous membrane near the cardiac orifice of the stomach presented a ragged appearance, dating to the prolonged manipulations. The plate was very firmly fixed in the œsophagus, 1½ inch above the cardiac opening.

DIGITAL DILATATION OF THE ORIFICES OF THE STOMACH.

We owe this operation to Prof. Loreta,* of Bologna, whose two first cases Mr. Holmes was, I believe, the first to bring prominently under the notice of English surgeons.

DILATATION OF THE PYLORUS.

Indications.†—In deciding as to the justifiability of the operation, we must consider—(1) the diagnosis; (2) the failure of previous treatment.

(1) *The Diagnosis.*—Cancer and idiopathic gastritis are the chief conditions which must be distinguished from simple fibrous stricture of the pylorus.

(*a*) Cancer.—This may be excluded by the long course of the symptoms, the delay in the onset of cachexia and exhaustion, and by the age‡ of the patients.

(*β*) Dilatation due to Idiopathic Gastritis.—Prof. Loreta points out that here the diagnosis will be aided by attention to the following:—If the matters rejected or extracted from the stomach in the two diseases are allowed to settle, and then examined, the deepest layer of the sediment in cases of obstruction from fibrous stricture will be found to consist of acid chyme well digested, and the patients here have appetite or even hunger after vomiting; that, on the contrary, in idiopathic gastritis the deep layer of the vomit contains much undigested detritus and but little chyme, and that after vomiting there is indifference to or loathing of food. Prof. Loreta explains these differences by the fact that in the mechanical obstruction the coats of the stomach are more likely to be uninjured, and that thus gastric digestion still goes on and the peptones are still absorbed.*

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* Prof. Loreta's first case is reported in the *Lancet*, August 18, 1883. The ninth operation, one of dilatation of the cardiac orifice, is briefly given in the same journal, April 26, 1884. Mr. Holmes' summary, a very full one, of two papers by Prof. Loreta, will be found in the *Brit. Med. Journ.*, February 21, 1885. Any surgeon about to perform these operations should refer to this. Mr. Haggard's case—the first successful one performed by an English surgeon—was published in the *Brit. Med. Journ.*, February 19, 1887. In the same journal for March 17, 1888, is a note that the patient continues perfectly well.

† Those for the pyloric and cardiac operation are included here.

‡ Thus, in six of the cases mentioned in Mr. Holmes' paper the ages were eighteen, twenty-four, twenty-six, twenty-one, thirty-four, and "a young woman."

(2) *Failure of Previous Treatment.*—If this, carefully persevered with, and including washing out the viscus, has failed to prevent emaciation and exhaustion; if the vomiting is so constant as to make it certain that rectal nourishment will shortly have to be resorted to, the time for operative measures has come.

Operation.—The stomach should be well washed out † a few days before, and also on the morning of the operation, with dilute solutions of boracic or salicylic acids, and the time fixed should be as early as possible in the day. The previous meals should be fluids, small in amount and readily digested. The skin being cleansed, an anæsthetic given, and the parts relaxed, an incision about 5 inches long is made either in the linea alba or on the right side of the middle line, from a point about 1 inch below and outside the xiphoid cartilage to one just below the cartilage of the ninth rib. Hæmorrhage is arrested before the peritonæum is opened, and one or two fingers introduced to feel for and examine the pylorus. No definite tumour will probably be felt, but distinct hardness of the pylorus. If the omentum is adherent to the stomach, it must be separated after both this and the pylorus are drawn out of the wound. Sponges are now most carefully packed around the pylorus, and the stomach is opened, with blunt scissors, about the centre of its anterior aspect, but rather nearer to its pyloric end.‡ Any bleeding points are secured by Spencer Wells' forceps; then the right index examines the condition of the pyloric orifice. While attempts are made to dilate it, this end of the stomach is steadied by the left hand. Much gentleness and patience must be used in applying the great force which is often required for dilatation. Mr. Haggard, finding that he could not introduce his finger, used a pair of dressing-forceps, and, having thus started the dilatation, followed it up by the passage of a female urethra dilator (probably having guarded the blades with drainage-tube), and dilated gradually till he was able to get his "index and next finger into the duodenum without feeling them at all tightly packed." Prof. Loreta, in his first case,§ having introduced his right index, found that "no force that could be safely used succeeded in dilating it till the left index was also introduced and employed to steady the pylorus. When this was done, the end of the right forefinger was gradually squeezed through the aperture. Then the finger was used to hook down the pylorus towards the abdominal wound, a manœuvre which enabled the operator to get the left index also through the pylorus. But it was still exceedingly difficult to effect any separation of one finger from the other, so great was the resistance, not only of the sphincter itself, but also of the coats of the stomach and duodenum. The attempt at dilatation threw the muscular fibres into spasmodic action, which quite overcame all the force that could be exerted. Three such attempts were made in vain, but then the pylorus began slowly to yield to the force employed, which was very considerable. At length a sensation was experienced, 'showing that the tissue was so far distended that it could not obey the dilating finger further without being torn.' The fingers were now kept apart for a short time, and the spectators noted that one finger was about 8 centimetres (more than 3 inches) from the other."*

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* These points and several others are fully put forward in Mr. Holmes' paper. Prof. Loreta moreover points out that, if the mechanical obstruction has lasted sufficiently long, disease of the coats will ultimately take place, thus rendering examination of the vomit alone fallacious.

† This may also bring about some contraction of the viscus.

‡ Of course, any large vessels will, as far as possible, be avoided.

§ The patient was aged forty-seven, and symptoms of dyspepsia had lasted twenty years.

The wound in the stomach is next closed with Lembert's suture, of carbolized silk; or the method employed by Mr. Thornton, p. 820, may be made use of. The sutures should pass through any points that still bleed after forcipressure is stopped. If any ligatures are really required, fine chromic gut should be used. Perhaps the introduction of a sponge during the insertion of the sutures may facilitate this step by everting the mucous membrane. When the stomach is soundly closed, the sponges are removed from the peritonæal cavity,† the viscus replaced, and the wound in the abdomen carefully closed. It should be noted that in Mr. Haggard's case "terrific bleeding followed the incision" into the stomach, and was difficult to arrest completely during the suturing of the stomach. Pure blood was vomited on the third day, and about two teaspoonfuls on the sixth. As Mr. Treves points out (*loc. infra cit.*), if care is taken to make the opening in the stomach only large enough to just admit the index finger, it will be securely plugged.

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* However the dilatation is effected, it should be kept up for a few minutes.

† If any cleansing of the peritonæum is required, this will be done now. To prevent any chance of leakage, sutures should be placed at the very angles of the wound, or even beyond them, as recommended by Sir W. MacCormac in suture of the bladder (Fig. 123).

Mr. Treves has published (*Brit. Med. Journ.*, 1889, vol. i. p. 1105) another successful case of this operation. The mischief here, perhaps, arose in a kick from a horse three years before. The pylorus was at first difficult to define. It appeared to be imbedded in a mass of almost cartilaginous hardness, which was firmly adherent to the under-surface of the liver. Not only was the pylorus itself, but the stomach as well, for some 3 square inches, was in like manner adherent. The adhesions were inflammatory, and were divided as freely as possible, but it was found impossible to entirely separate the stomach and pylorus from the liver. The pylorus was dilated, first with the index, then the middle finger of the right hand, and finally with both. The recovery was only complicated by an attack of vomiting on the seventh day. The patient was seen free from all stomach trouble a year later.

The after-treatment will be much the same as for gastrotomy, p. 820. Prof. Loreta seems to feed his cases by the mouth very early—"on the fourth day" (Haggard); according to his own paper, on the same evening; in his first case, every half-hour he gave teaspoonfuls of the yolk of an egg beaten up with Marsala. Mr. Haggard allowed nothing but ice to enter the mouth till the seventeenth day. The condition of the patient, and the way in which enemata are retained, must decide this.

DILATATION OF THE CARDIAC ORIFICE.

This operation, introduced by Prof. Loreta* for non-malignant stricture of the œsophagus, and successfully performed by him in at least four cases, seems to me to stand on quite a different footing to the other as to usefulness. In the first case the inventor thinks that instrumental dilatation of the œsophagus through a wound in the stomach is much preferable to gastrostomy, owing to the almost uniform fatality of the latter operation. In this he seems ignorant of the results obtained in this country in favourable instances, and of cases in which the rest given by gastrostomy has enabled surgeons to dilate an innocent stricture previously impassable, and to close the gastric fistula later on (p. 818). Furthermore, it remains to be proved how far strictures of the œsophagus thus treated can be considered, as Prof. Loreta claims for his operation, radically cured. For the surgeon is here not able to get as directly at the disease as in dilatation of the pylorus, and Prof. Loreta allows in another part of his paper that the cure here may be only transitory and partial, as in the case of the cardia the surgeon loses the peculiar sensation to his fingers of fibres so far stretched as to have entirely lost their tonicity and power of resilience. It will probably be well to keep up the dilatation of a stricture thus commenced from the stomach by means of bougies passed from the mouth.

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* In 1885, as mentioned by Mr. Holmes (*loc. supra cit.*).

Operation.—The following account is from that given in Mr. Holmes' paper of the first case thus operated on by Prof. Loreta.* The patient, aged twenty-four, had swallowed caustic alkali. Attempts to dilate the stricture by bougies were unsuccessful, and at last it became impossible to pass any instrument. The point at which the sound was arrested seemed to correspond with the fourth dorsal vertebra. The patient was entirely unable to swallow, and emaciation had become extreme. Eleven months after the injury an incision about 5 inches long was made from the xiphoid cartilage downwards and to the left. Some difficulty was met with in finding the stomach, owing to its contraction and the way in which the liver overlapped it; but at length the operator succeeded in drawing the greater part of the stomach out of the wound, and a longitudinal incision was made through its walls between the two curvatures, having its upper end as near the cardia as possible. The next step was to find the orifice of the œsophagus, in order to introduce the dilator; but this involved considerable difficulty,† and the search was interrupted by a considerable quantity of bile, which regurgitated from the duodenum into the stomach. At length, by searching with the left index between the under-surface of the liver and the small curvature of the stomach, the end of the œsophagus was found. Then the distended stomach was kept drawn down by an assistant while the operator introduced a dilator (something like that of Dupuytren for lithotomy). The wound was then sewn up and the stomach returned. The patient rallied well, and in six hours swallowed some soup, with the yolk of an egg, to his great joy, as for twelve months he had been unable to do more than swallow spoonfuls. Recovery was complete in about eighteen days, but on the fourth day after the operation he was seized with dyspnœa and abundant mucous expectoration from the trachea and bronchi. This same disturbance took place in another case. Prof. Loreta is uncertain whether it was due to irritation or paralysis of the sympathetic or vagus during the dilatation, or to inflammatory exudation.

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* Four cases in Prof. Loreta's hands, and two under other Italian surgeons, all recovered.

† The surgeon would be guided by Prof. Richardson's directions (p. 821).

EXCISION OF THE PYLORUS.

This operation, which we owe especially to German surgeons, Billroth, Woelfler, Gussenbauer, and v. Winiwarter, cannot yet be said to be definitely accepted in English surgery. To my mind, the very high mortality and the rapidity of recurrence render it extremely doubtful whether this operation should ever be performed, even in the apparently most favourable cases. But I ought to state that this is the outcome of an examination of published cases, and not from any personal experience of the operation.

Indications.[*]—Is the operation ever justifiable? and, if so, in what cases?[†] What are the *results* and the *mortality?* Dr. Winslow (*Amer. Journ. Med. Sci.*, 1885, N.S., vol. lxxxix. p. 345) has collected fifty-five cases in which pylorectomy was performed for cancer. Of these, forty-one died from the effects of the operation, giving a mortality of about 76 per cent. Mr. Butlin (*Oper. Surg. of Malig. Dis.*, p. 217) quotes Bramer (*Cent. f. Chir.*, 1885, p. 548) as having collected seventy-two cases of pylorectomy for cancer, of which fifty-five died from the operation, a mortality again of about 76 per cent.

Duration of Cure.—Mr. Butlin (*loc. supra cit.*) shows that all the cases which have been properly reported are either dead or suffering from recurrence. All save one died in a period of from four to eighteen months. The exception was one of Woelfler's, which remained well for a year, and then had recurrence in the cicatrix which was operated on. Later on the groin glands became affected, and four years after the pylorectomy the patient was dying slowly of cancerous recurrence. In Mr. Butlin's words, "There is not one, therefore, of those who recovered from the operation who can be claimed to have been really cured of the disease. . . . . Yet the cases in which recovery from the operation took place were, so far as could be judged, singularly favourable for the operation. In the very large majority of them the disease was very limited in extent, was not complicated by adherence to the surrounding parts, while the glands, as far as could be seen, were not affected by the cancer."

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[*] I have only referred to pylorectomy for malignant disease here. For cicatricial and non-malignant obstruction, a trial of Loreta's method (p. 823) should be made.

[†] Mr. Greig Smith (*loc. supra cit.*, p. 392) writes: "If the patient is not in fairly good condition, if the stomach is greatly dilated, if the growth is large, fixed, and displaced, the operation ought not to be contemplated. And, even when the obverse conditions are present, it is doubtful if it could ever be a surgeon's duty to advise the operation; he ought to undertake it only at the patient's urgent request, and after fully and honestly explaining to him the hazardous risk which he undergoes."

Mr. Butlin goes farther when he states his belief that, while no patients have been cured by this operation, the relief it gives is not likely to be abiding, as the recurrence in several has taken place *in situ*, and that this causes as much suffering as the primary disease.

With regard to statistics, it should, I think, always be remembered—(1) that a very large number of these cases have been treated by hands especially practised in this operation, and yet the mortality is extremely high; (2) that the statistics do not give the whole mortality, as it is highly probable that a large number of operations have been performed with unsuccessful results, and therefore not published.

Time alone will show whether the above adverse opinion is unjustifiable. Any surgeon deciding to operate will weigh carefully the following in a case of undoubted malignant obstruction.

i. Is the mass localized to the pylorus?—*i.e.*, how far is it (α) without any secondary deposits? (β) free from adhesions? It is probably quite impossible to be certain as to these points. While in many cases cancer of the pylorus may remain long limited to the pylorus itself, it is very liable to infect the lymphatic glands around the head of the pancreas, and to cause secondary growths in the liver and other parts. Adhesions, too, are very frequently* met with between the stomach and the colon, pancreas, and liver. The following cases show how easily the surgeon may be mistaken in these points. In Mr. Southam's patient (*Brit. Med. Journ.*, July 29, 1882—an instructive paper, from which I shall again quote later), aged forty-three, though the hard nodular mass in the situation of the pylorus moved with respiration, and shifted as the patient moved from side to side, though the symptoms were only of four months' duration, and the disease appeared to be limited to the pylorus, there was a mass of enlarged glands surrounding the head of the pancreas, and some slight adhesions of the stomach to these. Mr. Morris mentions a patient of Prof. Lietherin's in whom, though the growth could be easily moved in different directions, it was found so firmly adherent that the operation had to be abandoned.

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* The statistics of Gussenbauer and Winiwarter (Langenbeck's *Arch.*, Bd. xix. S. 372, 1876) show that, of 542 cases of cancer of the pylorus, adhesions were present in 370.

Mr. Morris gives also (*Intern. Encycl. Surg.*, vol. v. p. 1107) the following instructive case:—"A man under my care in the Middlesex Hospital, with a movable cancerous mass in the pyloric region, consented to the operation of pylorectomy; his strength and general, as well as local, condition seemed favourable, and all the final preparations for the operation had been made, when some increased distinctness of the superficial veins of the abdomen, and some slight tumidity in the lumbar regions, suggested the advisaability of watching and waiting for a day or two. Within a week the whole abdomen was distended with ascitic fluid, the surface veins were greatly enlarged, and the lower limbs œdematous. The patient lingered on several weeks, and died with abundant secondary cancer. It is needless to speculate what might have been the result of the operation had it been attempted in this case."

ii. The strength and age of the patient. The general condition, power of repair, &c., must be sufficient to justify the patient being submitted to an operation on very vital parts, which will certainly take an hour and a half, and may take between two and three.

iii. The rate at which vomiting, pain, and emaciation are increasing.

iv. The amount of dilatation of the stomach, and how far this yields to washing out.

Operation.—For some days before the operation the stomach should be washed out with tepid water, siphon-fashion, by an india-rubber tube and funnel, till the contents come out clear, this being done more frequently according to the degree of dilatation of the viscus. Immediately before the operation* the stomach is again washed out with some dilute aseptic solution, as salicylic acid. For some time beforehand the patient must be fed with that food which is found to cause least vomiting. In Mr. Southam's case this was found to be peptonized milk and custard.† The bowels should be well cleared out with enemata, and every precaution at the time of the operation should be taken against shock—viz., wrapping up the patient well, hot bottles, bandaging the limbs in flannel, keeping the head low, the administration of ether if possible for the greater part of the operation, and subcutaneous injections of ether and brandy.

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* In Mr. Southam's case the need of this final washing was proved by the fact that a quantity of dark-coloured grumous matter was brought away, which otherwise might have escaped into the peritonæal cavity.

† Nothing should be taken by the mouth for twelve hours before the operation.

Various *incisions* have been made—viz., (1) A vertical one in the linea alba, above the umbilicus. (2) A vertical one in the right linea semilunaris, or through the rectus, tearing its fibres so as to avoid hæmorrhage (p. 817). (3) Obliquely from above downwards, and from within outwards, between the umbilicus and right ribs. (4) More transversely over the tumour.* Either of the last two gives more room, and thus better access to the growth. But as both are accompanied with more hæmorrhage, and are more difficult to close†—a point which may be of much importance at the close of such an operation—a free oblique incision, 4 to 5 inches long, commencing a little to the left of the middle line, but not completely dividing both recti, is by some preferred. All hæmorrhage being first arrested, the transversalis fascia and peritonæum are pinched up and opened so as to admit two fingers, which examine the growth, the presence of adhesions, enlarged glands, invasion of the liver, pancreas, or colon, or curvatures of the stomach itself. If the disease is so localized as to allow the surgeon to go on, the opening in the peritonæum is enlarged so as to get a better view of the disease, and to enable the mass to be drawn forwards with vulsellum-forceps. This having been done as much as possible, the stomach is packed around with hot carbolized towels or sponges, so as to prevent any escape of fluids into the peritonæal cavity. The omenta are next separated with scissors, either between double ligatures of carbolized silk or chromic gut previously passed with an aneurism-needle, or between large pairs of omental clamp-forceps, the tissues being cut piece by piece, and each bleeding point taken up.

Excision of the Diseased Pylorus.—Previous to this, towels or sponges should be still more carefully packed around the stomach, and the duodenum should be secured, either with a ligature of thick silk tied round it well wide of the disease, or by a clamp, as in Fig. 120. The ligature seems preferable, as it not only prevents escape of contents and controls hæmorrhage, but also gives a secure hold, preventing the intestine slipping, and allowing it to be drawn over towards the cardiac orifice. The duodenum is then cut through, as in Fig. 130, with scissors, at least ½ inch from the disease. This incision, oblique, so as to diminish as far as possible the difference in the openings between the stomach and duodenum, is made with a series of clean, careful snips, any bleeding points being secured at once with Spencer Wells' forceps if few, and with fine chromic gut if numerous.

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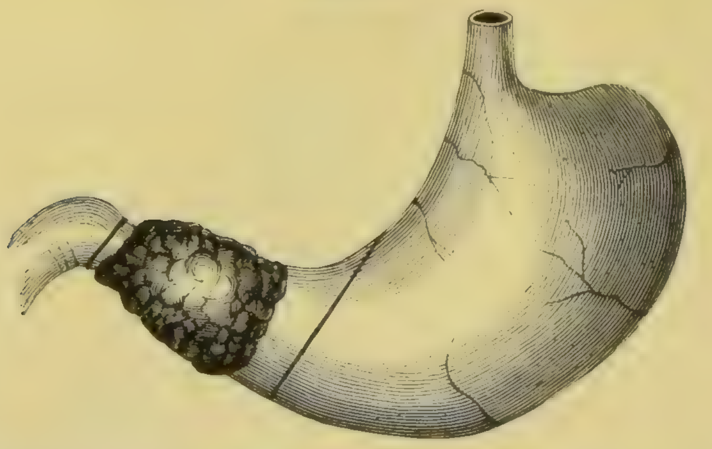
* If this has sunk very low, it must first be raised, if possible.

† In Mr. Southam's case, the incision, 6 inches long, was made 2 inches above the umbilicus, and across both recti; the contraction of these muscles led to much difficulty in adjusting the abdominal wound.

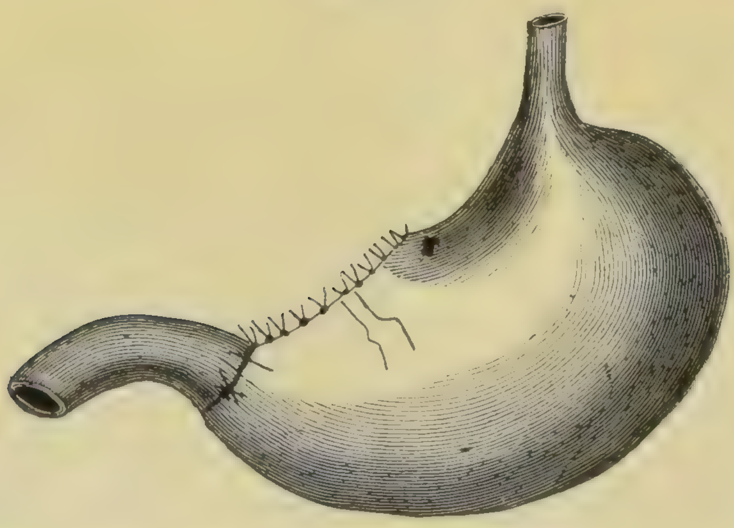
FIG. 130.*



Oblique division of the stomach and duodenum in pylorectomy. Billroth in this case made half the division of the stomach first, united this with "occlusion sutures," next severed the rest of the stomach, then the duodenum, finally uniting this to the greater curvature. (Billroth.)

The section of the stomach has been made in different ways. The most usual one is shown in Fig. 130. The section is made obliquely, with the precautions already given in the case of the duodenum. As the cut end of the stomach is so much larger than that of the duodenum, the former must be reduced by suturing

FIG. 131.



Duodenum united to the greater curvature; ten occlusion sutures unite the upper part of the cut stomach. (Billroth.)

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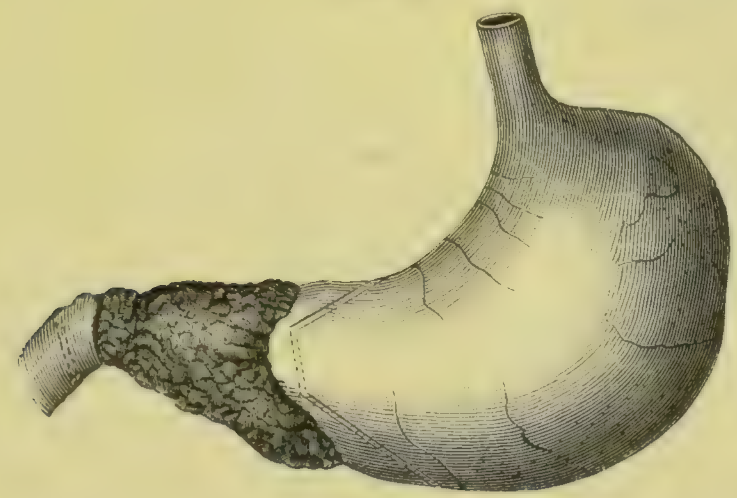
[*] This and the next four figures are taken from Prof. Billroth's *Clinical Surgery*, pt. iii.

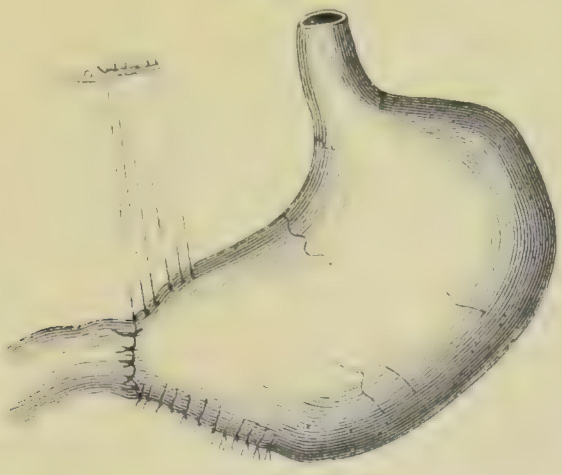
part of it before it is completely divided. The surgeon will decide whether he will unite the duodenum to the greater or lesser curvature, or to the part between the two.* In the former case he cuts the stomach from above downwards, and from left to right, and it will be well to unite that part of the stomach which will be superfluous before the section is completed (Fig. 131). The same course is followed if the duodenum is united to the lesser curvature; but here the section is made from below upwards, and from right to left. Figs. 132, 133, show the mode of uniting the duodenum midway between the two curvatures.

FIG. 132.



(Billroth.)

FIG. 133.



(Billroth.)

Closure of the Stomach, and Union of this and the Duodenum.—That part of the stomach which is superfluous is closed with carbolized-silk sutures, inserted by Lembert's method, the sutures being left long and held in forceps, so as to steady and move the stomach and thus facilitate its union with the duodenum.

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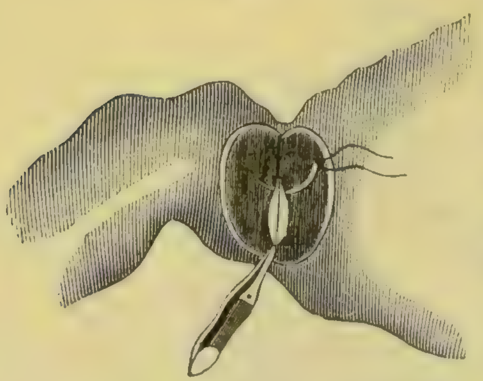
* Prof. Billroth prefers uniting the duodenum to the greater curvature.

The ligature, or drainage-tube, on this being removed, it is united to the greater or lesser curvature, or centre, as follows, beginning with sutures passed from within (Fig. 134). These, of fine carbolized silk, are passed with a needle in a holder, first at the cut edge of the stomach between the mucous and muscular coats, carried on between the muscular and serous, then through the same layers of the duodenum, and finally brought out between these layers and the mucous membrane at the cut edge of the duodenum. When the posterior aspect of the two viscera is thus soundly closed, the anterior one is united by Lembert's suture. If the cut mucous membranes do not come accurately together, a few sutures may be put in here separately from within.

FIG. 134.



Insertion of the posterior ring sutures from within. (Billroth.)

Care must be taken in inserting the sutures to avoid the formation of any folds (Billroth). The same surgeon says it is well to put a few additional superficial sutures at the point where the borders of the duodenum join those of the stomach. If the stomach contains fluid in spite of the washing out, it must be mopped dry with carbolized sponges kept for this purpose alone, and it may be a help to introduce sponges into the cut ends while the sutures are being inserted, withdrawing them before the stitches are tightened. The sutures being carefully looked over and cut short, a little iodoform is rubbed in, the sponges or towels removed, and the stomach replaced. If any fluids have escaped into the peritonæal cavity, this must be carefully cleansed. The abdominal wound is then closed in the usual way and the dressings applied.

After-treatment.—This will be conducted on much the same lines as after gastrotomy, p. 820. Mr. Butlin (*loc. supra cit.*) points out that these patients, much let down and exhausted, will not last long on the administration of ice and nutrient enemata only. After the first thirty-six hours teaspoonfuls of milk should be given every half-hour or hour, gradually increased up to a pint in twenty-four hours at the end of a week.

GASTRO-ENTEROSTOMY.

The object of this operation is to make an opening between the blocked stomach and the small intestine as high up in the latter as possible, so that the food may still find its way into the intestine and there meet with the other digestive fluids. Owing to the great fatality of pylorectomy, this operation, or jejunostomy (p. 836), or that of curetting the disease will probably take its place, and not only in those cases in which excision of the pylorus cannot be performed owing to the condition of the patient, the presence of adhesions or secondary deposits, or by the growth involving the stomach itself as well as the pylorus.

Operation.—The preliminaries are the same as those given for pylorectomy (p. 830). The following account of the operation subsequent to exposure of the stomach is taken from a very successful case of Mr. Barker's (*Brit. Med. Journ.*, February 13, 1886).—" After pushing the omentum, which was not voluminous, to the left, the first part of the jejunum was caught in the fingers, and a loop drawn out of the incision. The middle of the anterior surface of the stomach was also drawn out, and supported all round by warm carbolized sponges. I now passed a piece of india-rubber tubing through the mesentery at each end of the loop, and, having emptied the portion of gut by gentle pressure, drew the ends of the tubing tight enough to prevent access of the contents of the bowel into the loop to be operated on, and fixed each piece of tubing with catch-forceps. The empty loop of gut was now laid upon the portion of stomach to be opened, and a longitudinal fold of the latter, about 1½ inch from the great curvature, was pinched up between the finger and thumb of the left hand, together with the collapsed gut. I now made an incision about 1½ inch long in the fold of the stomach, and another corresponding in the approximated fold of gut. These incisions only penetrated through the serous and muscular tunics, and left the mucous coat of both viscera intact for the present. Still holding the parts, as before, between the finger and thumb, I now united the corresponding posterior edges of the wounds by a continuous suture, the needle entering and emerging in each case between the mucous and muscular coats, and the threads crossing the cut edges of the muscular and serous coats. In this way the serous surfaces were closely united from end to end before either viscus was opened. This row of stitches (which were about ⅛ inch apart) was carried about ¼ inch beyond each end of the incision in the coats of the bowel. The moment had now come to open both the stomach and intestine completely, and this was done with a stroke of the scissors through the mucous coat in each case, special sponges being ready to receive any fluid which might escape. A few drachms of *succus entericus* flowed from the bowel

—little or nothing from the stomach opening. After careful cleansing, the anterior borders of both openings were now united by a row of interrupted fine-silk sutures, introduced according to Czerny's method. When this was completed, the two openings were securely closed, but, as an extra precaution, the intestine was turned over, and the posterior suture was reinforced by a second row of interrupted sutures, placed about $\frac{1}{4}$ inch away from the first. The anterior was then similarly reinforced by a row of continuous sutures taking up, as before, only the serous and muscular tunics. Lest there should be any 'kinking' of the latter, as in one of Billroth's cases, I stitched its efferent portion to the stomach wall, about $\frac{3}{4}$ inch from the right extremity of the opening between the stomach and jejunum."

The rest of the operation and the after-treatment will be much the same as that already given (pp. 820, 834). The use of Senn's decalcified bone-plates (p. 776, Fig. 119) will probably facilitate this operation considerably.

Mr. Barker's case soon began to vomit turbid fluid, which became very fetid—apparently pancreatic secretion mixed with bile. This was checked by the use of creosote and placing the patient in the semi-recumbent position, which, allowing the intestine to slip down, caused its opening not to be exactly over that in the stomach.

DUODENOSTOMY.

This and the following operation have been proposed, in cases unsuited for pylorectomy, as a means of getting nourishment into the alimentary canal below the disease, and thus giving rest to the diseased parts. Time alone will show how far these are preferable to gastro-enterostomy; but it is certain that duodenostomy, which has received but little favour, is destined to be dropped. It has the serious objections that it deals with a fixed portion of intestine, and one into which important fluids are poured, and thus may readily escape from a fistula made here. Furthermore, all the cases have, I believe, been fatal.

Jejunostomy, or gastro-enterostomy, will probably replace pylorectomy or this operation. The weaker the patient, the greater the need to shorten the operation, the more is the simpler operation of jejunostomy indicated.

JEJUNOSTOMY.

This operation has been performed in a few instances. One of these, which I had the advantage of seeing, was brought by Mr.

Golding Bird before the Clinical Society (*Trans.*, vol. xix. p. 70). The following remarks are mainly taken from my colleague's paper. Mr. Golding Bird was inclined to consider this operation as superior to gastro-enterostomy as giving the cancer much more complete rest, as avoiding the risk not only of extravasation of contents of bowel and stomach contents, but also of that obstruction of the colon which may be found to be due to the necessary bringing up of the small intestine from below it. Finally, by feeding both toward and from the duodenum, perfect intestinal digestion can be carried on. This was proved by the rapid improvement in Mr. Golding Bird's case. The patient died on the ninth day from an accident in the feeding.

Operation.—The precautions as to feeding and washing out the stomach have been already given (p. 830). The operation is performed in two stages. A vertical incision being made in the linea alba or right linea semilunaris, and the peritonæum opened with the precautions already given, the transverse colon and great omentum being drawn up, the omentum pushed over to the left, the first piece of small intestine which presents itself is seized. To bring this to the left, it is felt closely attached to the spine just above the aorta, and thus recognized as the commencement of the jejunum. A portion of this is then drawn forward in the lower angle of the wound, while the upper two-thirds of this are united. When this is done, the bowel is stitched to the edges of the wound by interrupted sutures, very much as in gastrostomy. The after-treatment of the two operations would be much alike.

TREATMENT OF GASTRIC CANCER BY THE USE OF THE CURETTE.

This new operation has been introduced by Prof. Bernays (*Ann. of Surg.*, Dec. 1887) with two most successful cases. As it is possible that it will replace other operations here, it will be briefly mentioned. Prof. Bernays, believing that cancer of the stomach, by the time it comes under the surgeon's hands, has ceased to be a local disease, and that therefore radical extirpation is out of the question, recommends gastrostomy followed by curetting.*

Having opened the peritonæal cavity—an incision to the left of the linea alba parallel with the ribs was used—the anterior wall of the stomach was found, and punctured with a trocar so as to let off the gas. The parietal peritonæum was then united to the edges of the wound and the stomach (about the centre of its anterior surface) stitched most carefully to the parietal peritonæum and muscles. The wound was then irrigated with 1 in 20 carbolic acid, to prevent, by its slightly caustic action, any infection from the contents of the stomach. The stomach was then opened for 1½ inch, very little bleeding following, and the lips of the stomach wound and that in the skin united by thirty-six silk sutures. The stomach was now well washed out with warm water, and a soft growth felt nearly filling the pylorus, but leaving the lesser curvature intact. With two fingers half this was now removed. Most profuse bleeding followed, but ceased when the hard base of the tumour was reached with a sharp spoon, and the stomach was irrigated with cold carbolized water till this ran out clear. Nine hours after the operation the patient was allowed to take glasses of milk at intervals, but none came through the dressings, these not being changed till the fifth day. The fistula should be kept open for repetition of the curetting. In one case 14 oz., in the other 14 drs., of growth were removed. In the second case, great difficulty was met with in dilating the pylorus, the carcinoma here being much harder and circular. The history of the cases is not complete, but it is clear that very great relief was given in the few months which had elapsed since the operations, the patients gaining weight, ceasing to vomit, and no longer needing morphia.

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* The fact that cancer here grows towards the cavity of the organ, and the relief given by repeated curetting in uterine cancer, first led him to attempt this.

CHAPTER VIII.

EXCISION* OF THE SPLEEN.

Indications.—All of these are rare, and many of them are still doubtful.

1. Cystic spleen. When this is found unsuited for drainage. Mr. K. Thornton's case of this kind was the first successful splenectomy in England. 2. Injury. This has been already alluded to when gunshot injuries of the abdomen were considered (p. 797). Other cases in which it may be called for are, prolapsus of a spleen, injured or not, through a wound, rupture of the spleen, and stabs of this viscus. 3. Movable or wandering spleens. When this condition causes troubles, analogous to those of movable kidney, not relieved by a belt. Dr. McGraw (*Med. Rec.*, vol. xxxiii. No. 26) removed an enlarged and dislocated spleen, which formed a tumour in the right iliac fossa, and partially displaced the uterus and bladder. A week later pain in the left shoulder and left-sided pleuro-pneumonia supervened. Nine months afterwards the ligature was coughed up. Recovery followed. The remaining conditions are much more doubtful. 4. Malignant disease. Primary sarcomatous or carcinomatous disease of the spleen is extremely rare. The only case I can quote is one removed for primary sarcoma by Prof. Billroth (*Lancet*, June 7, 1884). Mr. Butlin, referring to the same case, says that it was reported, shortly after, that recurrence had proved fatal in a few months. 5. Hypertrophy of the spleen. The operation must here be limited to those rare cases in which simple (non-leukæmic)†—*e.g.*, malarial—enlargement of the spleen resists other treatment. In Mr. Thornton's table, in fourteen cases of splenectomy for "Hypertrophy," four were successful, and ten fatal. 6. Leukæmia. This operation has been so invariably fatal that it ought to be abandoned.‡

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* Cases in which the spleen was *incised* for suppuration will be found in the *Brit. Med. Journ.*, vol. ii. 1887, p. 1047, and vol. i. 1888, p. 586.

† It seems to me that this distinction has not been sufficiently made. Several of the cases operated on read like an early condition of leukæmia, and in those ending fatally the rapid onset of death after the operation is often suggestive of the ending of leukæmic splenectomy.

‡ Mr. Greig Smith gives 18 cases; Mr. Thornton, 13; Mr. Collier, 16—all

G. A. Wright, of Manchester (*Med. Chron.*, Dec. 1888), draws these conclusions from a study of the cases of removal of the spleen: "(1) Splenectomy for leukæmia is inadmissible. (2) Splenectomy for hypertrophy is very dangerous, the chief danger being from hæmorrhage and shock, and there being especial danger of bleeding from a vessel that passes between the spleen and the diaphragm. Whether it is altogether an abnormal vessel or merely a dilatation of a small vessel existing there, I do not know, but it is responsible for the death of my patient, and of three others, including a leukæmia patient. (3) If malarial cases require removal of the organ there is a good prospect of recovery. (4) Cases of floating spleen and of simple cyst are eminently favourable for operation. (5) From a special consideration of my own case, I should say that in a patient with simple hypertrophy or chronic splenitis, a careful examination of the relations of the organ should be made before dividing any vessel, and if large adhesions to the diaphragm are found, and the spleen is firmly fixed, and the pedicle broad and ill-defined, the operation had better be abandoned. It is, of course, impossible to stop if once there is any laceration of the splenic tissue, since the bleeding can only be arrested by removal of the organ. If removal is found to be impracticable, the question of ligature of one or more of the main vessels supplying the spleen is worth considering. Ligature of the splenic artery was suggested by Lucas, but has, so far as I know, never been tried."

Operation.—The preliminary steps will be directed to ensure asepsis and to diminish shock (p. 830). The incision has usually been one in the linea alba. That in the linea semilunaris, or one further out (Bryant), from the left anterior superior spine to the ribs, would probably give better command over the pedicle. All hæmorrhage being stopped, the peritonæum is opened freely and the hand explores the tumour. Any adhesions, as of the overlying omentum, are separated, being ligatured if needful. The spleen is now brought out of the wound, the lower extremity first, and either carbolized sponges or towels are carefully packed around it. This extraction of the viscus must be carried on with the utmost caution and gentleness, as its friability may easily lead to a tear and most profuse oozing, and as dragging on the pedicle may easily induce collapse and is also likely to lead to some small vessel retracting from the ligatures as they are applied, and causing fatal hæmorrhage.

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fatal. The only case which has recovered—Franzolini's, of Turin (*Wien. Med. Woch.*, 1883, No. 20)—is considered one of hypertrophy by Thornton, Collier, and Crédé.

The spleen being wholly outside the body, the most important part of the operation, securing the pedicle, remains. This structure, if present,* must be carefully examined. If the patient's condition is good, the safest plan will be to secure the vessels as far as possible separately, the pedicle being divided, as Mr. Greig Smith (*loc. supra cit.*, p. 563) suggests, piecemeal between pressure-forceps ; where there is not time for this, it will be wiser to secure the vessels in two or three portions, transfixing in two places, and locking the ligatures (Thornton). Carbolized silk should be used, fairly stout, and not tied too tightly so as to cut its way. However the pedicle is treated, the following precautions should be followed :—(1) To prevent any tension being exerted on the pedicle (*vide supra*). (2) To secure every vessel. (3) To divide them, in a relaxed condition, at a sufficient distance from the ligatures. (4) Not to include the tail of the pancreas. (5) After all the ligatures have been applied, it may be well for safety to throw one round the whole. (6) Not to twist the spleen round at all in dealing with the pedicle.†

The abdominal cavity is next cleansed and the operation completed as after ovariotomy. The after-treatment is also much the same.

Causes of Death.‡—By far the most frequent is hæmorrhage. This may be from the omentum adherent over the spleen, from the large vessels to this viscus, from some small vessel which has retracted, from the splenic vein, or from sponge-like adhesions (Bryant). Mr. Hatch, of Bombay (*Lancet*, 1889, vol. ii. p. 1053), met with a case in which death took place a few hours after the splenectomy, owing to oozing from some adhesions between the spleen and the diaphragm, which had required separation.§ The pedicle was safely secured. In another case (*Centr. f. Chir.*, July 18, 1885), death, twenty-four hours after the operation, was due to bleeding from the abdominal incision, owing to the defective coagulation of leukæmic blood. The ligature on the pedicle was firm.

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* In a case of Mr. L. Browne's (*Lancet*, vol. ii. 1877, p. 310) there was no pedicle as such, four very large arteries being met with and secured with double ligatures.

† Sir S. Wells (*Med. Times and Gaz.*, January 6, 1866, p. 4) draws attention to this. Having done so in order to bring the vessels into a cord, the splenic vein was ruptured.

‡ Adelmann, to render splenectomy safer, has suggested its performance in two stages.

§ See also G. A. Wright's case (*loc. supra cit.*). This surgeon suggests the use of a long, sharply curved tenaculum for stopping bleeding from a deeply seated vessel in the back of the abdomen.

CHAPTER IX.

OPERATIONS ON THE LIVER AND GALL-BLADDER.

HYDATIDS.—HEPATIC ABSCESS.—TAPPING AND INCISING THE GALL-BLADDER. — REMOVAL OF BILIARY CALCULI. — EXTIRPATION OF THE GALL-BLADDER.

OPERATIONS FOR HYDATIDS.

This will include different forms of puncture, free incision, and electrolysis. The milder measures of puncture and electrolysis have proved successful in many cases, but we do not know for certain how the death of the parasite is brought about by them in successful cases, and they are largely uncertain.

A. **Puncture.**—While incision is the only certain and reliable mode of cure, it is worth while to try the different forms of puncture, especially in certain cases.

There is no need to do more than to describe briefly such an operation as this, and to tabulate the chief practical points.

The parts being cleansed, and an anæsthetic* given if the patient is very nervous, the surgeon chooses a spot for puncture at the most prominent part of the tumour, satisfying himself as to dulness.† If the skin is thick he makes a minute puncture with a scalpel and sends in a fine trocar or aspirator needle. The quantity withdrawn must vary with the case, the size of the cyst, the timidity of the patient, &c. From six to sixty ounces are instances of small and large quantities. The aspirator should, on the whole, be preferred, as likely to remove more fluid, and

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[*] It is well to dispense with this, if possible, from the possibility of leakage taking place after the subsequent vomiting. As an injection of cocaine will give almost as much pain as the fine trocar, the part may be frozen with the ether spray if needful.

[†] If this is presenting against the right ribs, another spot should, if possible, be chosen (foot-note, p. 844). Hydatids of the liver should never be explored or attacked through the ribs, if another site is obtainable.

thus, probably, more likely to produce a cure, but as the exhaustion is more likely to plug the cannula, a fine wire must be in readiness.* Escape of bile, blood, or the setting up of a cough are indications for stopping. While the cannula is withdrawn the surrounding parts should be pressed around it, and rather depressed, to diminish the risk of leakage as the cannula leaves the cyst. The puncture is then closed with iodoform and collodion, a small pad of dry gauze, and salicylic wool comfortably secured with a many-tailed bandage. A little opium or morphia should be given for the first twenty-four hours. The instruments used should be scrupulously clean, and, in hospital practice and in towns, the additional trouble entailed by irrigation with a solution of hyd. perch. will not be thrown away.

Practical Points.

1. Puncture alone is more likely to be radically curative in the following cases:—A small cyst, seen early. An acephalocyst. The more daughter-cysts, brood-capsules, and scolices are present, the less likely it is that puncture will suffice. 2. Puncture is often very useful as a means of diagnosis in these obscure cases, in which hydatids of the liver simulate disease of the pleura or lung. 3. Incision should be made use of where tapping fails, where scolices instead of fluid form the greater part of the contents of the cyst, where suppuration is present or imminent, and where chest complications are set up by the hydatid, showing perhaps a risk of perforation. 4. A few weeks after puncture secondary enlargement is often noticed. This is not undesirable as long as it subsides, which it usually will do gradually, being due to inflammation. On this account Dr. Fagge advises that no second operation on a hydatid should be performed within twelve months, unless suppuration is present. 5. Leakage after puncture may be shown by fluctuation, more or less distinct, in the flanks. The result of this seems to have been variable. In some cases it has been absolutely harmless, as in a case of electrolysis of mine mentioned below. In others it has been as certainly followed by fatal peritonitis. 6. Cases of hydatids treated by puncture should be watched for some time to make certain that the cure is a sound one. 7. The surroundings of hydatids of the liver are of

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* Dr. Fagge (*Medicine*, vol. ii. p. 321) thought that the value of the aspirator must depend entirely on the position of the hydatid. If a large part of the cyst is outside the liver-substance, the aspirator may be used with advantage; but if the cyst be almost entirely buried in liver-substance, Dr. Fagge thought the possible suction on a cyst surrounded by resistent tissue must involve some risk of setting up inflammation.

truly vital importance, and sudden death has followed an operation more than once. Thus, in Mr. Bryant's case (*Clin. Soc. Trans.*, vol. xi. p. 230) in tapping a hydatid cyst, the portal vein, which had been pushed upwards and forwards by the projection of the cyst on the under-surface of the liver, was transfixed. Death followed in five minutes, and was thought by Dr. Fagge to be due to hydatid fluid being sucked into the vein as the trocar was withdrawn.

In a Russian case (*Lond. Med. Rec.*, 1885, p. 414) the pulse suddenly stopped while the cyst, which had been exposed by abdominal section, was being stitched to the incision. At the post-mortem, a crumpled echinococcus had made its way into the right auricle, and a fragment of one into the right division of the pulmonary artery, by an opening between the thinned cyst and the inferior vena cava.*

B. **Incision.**—The indications for this in preference to tapping have been given above (p. 843). It may be performed in one or two stages. Surgeons owe their knowledge of the safety of the *one-stage method* to Mr. Lawson Tait. The operation is thus performed :—The parts being cleansed and the other preliminary steps taken, the surgeon makes an incision about 4 inches long over the most prominent part of the swelling † (previously carefully percussed) down to the peritonæum; all hæmorrhage is next arrested, and this layer carefully slit up. The liver is now recognized, and carbolized sponges or towels (p. 770) are carefully packed in on either side so as to prevent any escape of fluid into the peritonæal cavity.

The needle of an aspirator or a fine trocar is then thrust in, and the existence of fluid beneath thus verified. As the needle is withdrawn the liver is incised, and a finger quickly plugs, and then enlarges to 1½ inch, the opening made by the knife. Hæmorrhage, if free, is easily arrested thus, or by sponge-pressure. Escape of fluids into the peritonæal cavity is prevented by the use of the sponges already mentioned, by an assistant keeping the edges of the wound carefully adjusted to the liver, and, lastly, by the next step, which consists in hooking up the opening in the liver with the finger or forceps, and in stitching the edges of the wound in the liver to that in the abdomen with a continuous suture of carbolized silk. In inserting this, care must be taken to unite peritonæum to peritonæum, and to take up a sufficiency of tissue by inserting the needle well away from the edges of the wound. As the suture is inserted the sponges must be gradually withdrawn, and, if the fluid escapes very freely, it may be well to turn the patient over on his side. Any scolices which are within reach are next removed, and, if the cyst is firmly stitched and the patient's condition good, the contents of the hydatid may be cleared out with sponges on holders, aided by scoops. All handling must be of the gentlest. A large drainage-tube is then inserted, and dry sal-alembroth or iodoform gauze dressings applied.

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* Mr. Willett (*Brit. Med. Journ.*, November 13, 1886) mentioned a case in which he had to aspirate a doubtful swelling of the liver. He used an ordinary-sized needle, and within two minutes the patient was dead. It turned out to be a case of malignant disease. No large vein had been pricked, and there was no hæmorrhage. The fatal, sudden syncope seemed due to the impression made on the nervous system through the solar plexus.

† This incision should always be made in front. Even if a cyst or abscess shows its greatest point of prominence through the ribs, it should not be opened here if possible, as it is difficult to ensure adequate drainage, and the large drainage-tube needful easily causes caries of the closely adjacent ribs.

Operation by Two Stages.—This operation, based on the readiness with which two peritonæal surfaces adhere, is a very satisfactory one, being free from any risks of escape of blood or other fluids into the peritonæal cavity. I thus performed it in two cases of hydatid of the right lobe under the care of my colleagues Dr. Pye Smith and Dr. F. Taylor. An incision, 4 inches long, was made through the abdominal wall, about 2 inches to the right of the middle line, from just below the ribs to the level of the umbilicus. All bleeding being carefully stopped, the peritonæum was picked up and slit open. The liver, recognizable by its characteristic colour, was at once seen moving with respiration. To make certain of the position of the fluid, a fine trocar was now thrust in, one or two carbolized sponges being first inserted. In one case, which was crammed with scolices, very little fluid escaped; in the other, an acephalocyst, the fluid spirted out under the high pressure not unfrequently met with. After 8 oz. had been withdrawn, any leaking was stopped by sponge-pressure, the parietal peritonæum was stitched to the edges of the wound by a few points of chromic gut suture, the sponges removed, and dry gauze dressings firmly bandaged on with a good deal of pressure so as to keep the abdominal wall as far as possible in contact with the liver.* On the third day the operation was completed by incising the liver, now well adherent, and inserting a large drainage-tube. Both cases did well, though very slowly. One, a woman, three months pregnant at the time of the operation, went her full time subsequently.

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* One case bulged out the right lower ribs most markedly. For reasons already given, I preferred to attack it in the front of the right hypochondrium. On exposing the liver, a hydrocele trocar passed through 1½ inch of hepatic tissue before fluid was reached. Very little hæmorrhage followed the completion of the second stage of the operation.

C. **Electrolysis.**—This mode of treatment was used by Dr. Fagge and Mr. Durham in eight cases, and the results brought before the Medico-Chirurgical Society (*Trans.*, vol. liv. p. 1). The *modus operandi* here is uncertain, as in puncture, but it seems probable that neither the electrolytic action nor the leakage of fluid into the peritonæal cavity, but the puncture alone of the needle is the essential element.* This being so, and the method requiring special instruments, it has, I believe, fallen into abeyance. In one case, a patient of Dr. Moxon's, I made use of this method after previous tapping had failed. The steps taken by Dr. Fagge and Mr. Durham were carefully followed. Two electrolytic needles were passed into the most prominent part of the swelling, about 2 inches apart, and were then attached to wires both connected with the negative pole of a galvanic battery of ten cells. A moistened sponge connected with the positive pole was placed on the skin at a little distance. The current was passed for half an hour. The punctures were then closed with a pad of gauze. Indistinct fluctuation could be made out in the flanks during the next forty-eight hours. There was no constitutional disturbance, the tumour steadily diminished in size, and a good recovery took place.

HEPATIC ABSCESS.—HEPATOTOMY.†

As tapping by a trocar, and draining the abscess by the cannula left in, or a drainage-tube passed through the cannula, this being then withdrawn, is unsatisfactory,‡ and as the use of the aspirator here is mainly exploratory and palliative, it is to a free incision that we must look for a permanent cure. This may be employed in three ways—

1. Direct incision and drainage, when tenderness, œdema, and

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* Thus, in a case of Dr. Playfair's, related in the Appendix to Dr. Fagge's paper, progressive diminution, almost identical to that noticed after electrolysis, followed acupuncture only.

† This term is also applicable to incisions of the liver for hydatids.

‡ Thus (1) the cannula and tube may slip out. (2) The drainage is inefficient. (3) If the pus leaks into the peritonæal cavity, it does so unseen. (4) The trocar may puncture important parts. Thus, in one case of Mr. K. Thornton's (*Med. Times and Gaz.*, 1883, vol. i. p. 89), the omentum, containing large veins, lay over the liver. (5) Puncture and drainage would be quite insufficient in cases where more than one abscess existed.

redness, make it probable that adhesions exist. This needs no further comment. 2. Incision and drainage by abdominal section, in two stages. 3. Incision and drainage by abdominal section, at one sitting.

The methods of treating an hepatic abscess by abdominal section, whether in one or two stages, have already been spoken of at p. 844, under the heading of Hydatids. They have the following advantages over other modes of treatment:—(*a*) The benefit of a free incision and thorough drainage; (*b*) the surgeon can see what structures he is dealing with (see the foot-note above); (*c*) bleeding from the liver can be seen and arrested; (*d*) if pus escapes into the peritonæal cavity, this can be cleansed.

Very little need be said here of the treatment by abdominal section in addition to that already written at p. 844. In the two-stage method the surgeon will open the peritonæal cavity, suture the parietal peritonæum to the edges of the wound, insert some gauze, and endeavour, by well-adjusted bandaging, to keep the abdominal parietes in contact with the liver, opening the abscess on or after the third day.

In the method by direct incision, a free incision of 4 or 5 inches is made, and the position of the pus being verified by a fine trocar or aspirator needle, some soft carbolized sponges (previously counted) are carefully packed around. The abscess is then incised, and the opening at once plugged, and freely dilated with the finger. Any escape of pus into the peritonæal cavity is prevented (1) by the careful sponge-packing; (2) by the finger hooking up the liver against the wound; (3) by an assistant keeping steadily the parietes against the liver; (4) by seizing the edges of the liver with catch-forceps and so keeping them against the parietes. Hæmorrhage is prevented by the above forceps or sponge-pressure. When the abscess is empty,* its opening is plugged with a sponge, and the liver and the parietes being still kept accurately together, the sponges first inserted are removed,† and the edges of the liver wound stitched, with carbolized silk passed with curved needles on a holder, to the edges of the abdominal incision, care being taken to keep peritonæal

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[*] Mr. Greig Smith (*Abdom. Surg.*, p. 527) advises that, if the abscess does not empty itself readily, a large tube lying in carbolic lotion may be pinched at the end, and when placed at the bottom of the abscess will act as a siphon. He also draws attention to the need of exploring the abscess cavity for signs of a second abscess, and, if this be found, opening it with the finger or dressing-forceps. All manipulations now must be of the gentlest, for fear of hæmorrhage.

[†] If any pus or blood has escaped into the peritonæal cavity this must be now cleansed (p. 775).

surfaces well in contact. If the pus is fetid, the abscess cavity should be well irrigated with a dilute antiseptic lotion. A considerable thickness of dry gauze dressings will be needed at first, easily renewed by means of a many-tailed bandage.

TREATMENT OF HYDATIDS IN THE LIVER WHICH HAVE OPENED, OR WHICH THREATEN TO OPEN, INTO THE CHEST.—I refer here to those grave and difficult cases where a hydatid cyst or hepatic abscess, instead of making its way towards the abdominal wall, works upwards, thrusting up the base of the lung. Perhaps the first few tappings have drawn off fluids from the front, but after this the cyst recedes from the epigastric region as in Mr. Owen's case (*loc. supra cit.*). In other and rare cases the cyst or abscess has been opened from the front or the side, through the abdomen, but insufficient drainage is thus given. In such cases the advice given in the foot-note, p. 844, must be set aside, and the fluid must be drained through the pleura.*

Mr. Godlee sutured the diaphragmatic and costal layers of pleura round the edge of an aperture, made by removing a portion of rib, and then opened an hepatic abscess. Mr. Thornton, treating a similar affection with a view of obtaining a funnel, through the pleura, along which the pus could escape safely, first raised the parietal pleura all round, so as to get a little free edge, then made a very careful longitudinal incision through the visceral pleura, raised it all round, and then with a fine curved needle united the two layers with a continuous fine silk suture. A channel being thus made, the liver-abscess was opened by a curved trocar, the puncture converted into an incision, and a large drainage-tube inserted. Mr. Owen, in the case of a hydatid cyst which encroached upon the thorax, incised the eighth intercostal space, first behind the anterior axillary line. As soon as the costal pleura was divided, air rushed freely in with a very audible sound, and, the finger being introduced, the diaphragm was at once felt bulging up along the inner surface of the ribs, while the lung had retired beyond reach. The intercostal space, which was fairly roomy, was forcibly widened, but it was not thought necessary to excise a piece of rib. The phrenic pleura and the diaphragm were then carefully incised, and the abdominal cyst was discovered. A certain amount of its contents was withdrawn by aspiration, so as to relieve its tension, and to permit of some of the face of the sac being drawn through the diaphragm, and across the shallow pleural cavity to the skin wound, to which it was secured by four hare-lip pins. The serous surfaces thus placed in contact were found firmly adherent on the fourth day. An incision was then made into the cyst, and a drainage-tube inserted. All three patients recovered.

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* Mr. Godlee (*Brit. Med. Journ.*, 1887, vol. ii. p. 872), Mr. K. Thornton (*ibid.* 1886, vol. ii.), and Mr. Owen (*Clin. Soc. Trans.*, vol. xxi. p. 78) have successfully adopted this course.

TAPPING AND INCISING THE GALL-BLADDER.—CHOLECYSTOTOMY.—REMOVAL OF BILIARY CALCULI.

Indications.—The justifiability of, and the indications for, the above operations may be considered together, depending as they usually do upon the presence and effects of biliary calculi. The most favourable cases for operation are those where the site of the stone is known, either in the cystic or common duct, and where the gall-bladder is clearly distended.

1. Gall-stones.* When previous treatment has failed to relieve the patient from repeated crippling attacks of biliary colic and jaundice when the hepatic or common duct is blocked. 2. Dropsy and empyema of the gall-bladder. In a few cases this is due to stricture of one of the ducts after passage of stones or repeated attacks of catarrh. Mr. Barker mentioned a case (*Brit. Med. Journ.*, 1889, vol. ii. p. 983) in which, after operation for distended gall-bladder, no stone was found, but "the patient quickly benefited from the operation." Mr. Robson (*ibidem*) knew of two other similar cases. He thought the improvement which dated to the operations might be due either to freeing the gall-bladder from adhesions or to the free drainage which, by stopping the passage of thickened mucus along the ducts, restored the membrane to a healthier state. Dropsy and empyema are usually due to impaction of calculi, the bile gradually losing its colouring matter and becoming more and more mucoid and watery, and the

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* Mr. Tait (*Lancet*, 1885, vol. ii. pp. 239, 424) divides, for practical purposes, gall-stones into two classes—(1) the solitary; (2) the numerous. The former are seldom more than two or three in number, and often of considerable size. They are liable to be caught in the cystic duct, to give symptoms of blocking it, together with distension of the gall-bladder, but no jaundice, as the bile, prevented from entering the gall-bladder, flows constantly into the duodenum. The gall-bladder is easily opened, but the removal of the calculus from the duct may be very difficult. In the second class several hundreds of calculi may be present. As these from their size usually admit of a flow of bile past them, jaundice is seldom seen, and the distension of the gall-bladder is intermittent. The operation here differs considerably. As the gall-bladder is not distended, the diagnosis is more uncertain, and, when the abdomen is opened, the gall-bladder is less easily found. Care must be taken that no stones are left behind.

increased tension gradually causing suppuration. 3. Obstruction in the common duct. The most likely cause of this for the surgeon to deal with is a calculus. Very grave results, if this block be unrelieved, are jaundice and cholæmia (*vide infra*). 4. Certain cases of injury to the gall-bladder. Such are wounds, rupture, if any co-existing lesion is not going to be fatal, and bursting of an empyema of the gall-bladder.

The following indications for operation are given by Mr. Greig Smith (*Abdominal Surgery*, p. 541):—

"In every case of wound or perforation of the gall-bladder operation ought at once to be performed. Operation gives the only chance of recovery. In every case of empyema of the gall-bladder operation is indicated. Aspiration is only a temporary measure, and it is by no means free from danger.

"In every case of dropsy of the gall-bladder, operation is indicated. Aspiration may do no harm, and it may detect the presence of stone. But it is useless towards the removal of stone, and, generally, it has no beneficial effect on the disease.

"In cases of cholelithiasis, the indications to operate must be guided by the effects produced by the disease. The dangerous sequences of gall-stones* are frequently recurring attacks of hepatic colic, which wear out the patient's strength; jaundice, proceeding to dangerous cholæmia; and suppuration in the gall-bladder. The indication in each instance is strengthened by the presence of an enlarged gall-bladder.†

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* Death from uncomplicated impaction of gall-stones in the biliary ducts is no doubt rare. Such a case will be found recorded by Dr. Glover Williams (*Lancet*, 1887, vol. i. p. 1081). The fatal result was here due to constant vomiting and cholæmia. Another interesting feature in this case is the fact that about 3 inches from the edge of the right ribs, and at the junction of the umbilical and right lumbar regions, a hard mass the size of a large walnut could be felt. This proved post mortem to be due to calcareous glands.

† As the diagnosis of gall-bladder swelling is not always easy, it will be well to remember the direction in which the gall-bladder enlarges. According to Mr. Taylor (*Brit. Med. Journ.*, 1885, vol. i. p. 737), this is in a line drawn from the tip of the right tenth cartilage to the opposite side of the abdomen, crossing the middle line just below the umbilicus. Dr. Musser and Dr. Keen (*Amer. Journ. Med. Sci.*, Oct. 1884) state that the position of the gall-bladder differs with the age of its development. In an early stage it is found in the right hypochondrium; later it may occupy a position in the lumbar, hypogastric, or iliac region. I have spoken above of the occasional difficulty in diagnosis. Dr. Meads, of Philadelphia (*Trans. Amer. Surg. Assoc.*, vol. vii. p. 217), has published an interesting case in which a distended and movable gall-bladder simulated a movable kidney. After the kidney had been explored by the lumbar incision and stitched, further exploration revealed the presence of a tumour which occupied the position of the swelling so distinctly outlined before the operation. Pressure on this tumour brought it, covered with the parietal peritonæum, into the wound below the

"No general rule can be laid down as to the weight of the indication arising from hepatic colic. After months or years of intense suffering, many patients get well, and remain so. On the other hand, a patient's life may be rendered miserable, or his active existence as a bread-winner may be cut short, by persistently recurring attacks of hepatic colic. A time then comes when patient and surgeon both agree that it is proper to interfere. In all such cases the patient's desire must have great influence with the surgeon.

"In cases of persistent obstructive jaundice, operation is, at the same time, indicated and contra-indicated. Cholæmia, not only as weakening and depressing the patient, but also as predisposing to bleeding,* is an unfavourable element. In only seven of Musser and Keen's thirty-five cases of cholecystotomy was jaundice† present, and five of these died—half of the whole mortality. That the jaundice had much to do with this excessive death-rate there can be no dispute. This suggests early operation, before the patient's condition is lowered by cholæmia.

"Where evidences of suppuration appear in cholelithiasis, operation is to be urged. Every day that passes brings increase of danger.

"In cases of obstruction of the common or the hepatic duct,

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kidney. On incision of the peritonæum, it was found to be a distended gall-bladder. A calculus having been crushed and the débris pushed into the intestine (the freedom of the passage was announced by passage of intestinal gas), the gall-bladder was fastened to the lower part of the lumbar incision, just above the iliac crest. After the discharge of a little bile for two and a half months, the recovery was complete. Another very interesting case in which renal and biliary calculi co-existed has been recorded by G. A. Wright, of Manchester (*Lancet*, March 28, 1885); *vide supra*, p. 711.

* Dr. Musser and Dr. Keen (*Amer. Journ. Med. Sci.*, October 1884) state that where long-continued jaundice has disorganized the blood there is a marked hæmorrhagic tendency. In one of Mr. Robson's cases (*loc. supra cit.*), where the distension of the gall-bladder was caused by a cancer of the head of the pancreas, death, on the eighth day, was due to constant oozing of blood from the interior of the gall-bladder and the suture-punctures.

† Mr. Tait (*loc. supra cit.*), having met with no history of jaundice in fifteen cases of cholecystotomy, thus explains its absence. The common duct is not so long as the books say (viz., 3 inches), and it is more easily dilated than the cystic. A stone passing through the unyielding cystic duct causes great agony, but no jaundice. As soon as it enters the common duct, the whole excreting force of the liver comes into play, so that its passage is more rapid and gives no time for jaundice, which only occurs with long obstruction of the common duct. Mr. Tait (*Brit. Med. Journ.*, 1886, vol. ii. p. 906) brings forward another point with regard to gall-stones and jaundice which is most important. Gall-stones are not unfrequently associated with cancer. In cases where the jaundice is the principal symptom, cholecystotomy may give great relief to the pain but the jaundice persists, and death takes place from cancer.

cholecystotomy may simply prevent death by permitting escape of the biliary poison.* Patients can live without escape of bile into the intestines.† But Tait has shown us how a stone in the common duct can be crushed, so that even in these cases cure may be effected.

"In cases of obstruction of the cystic duct, operation in the majority of cases will not only relieve pain, remove danger of suppuration in the gall-bladder, but will also, in all probability, bring about complete cure."

Operations.—Tapping and incising the gall-bladder, and removal of calculi, may be considered together. It may be stated at once that aspiration by itself should not be practised. It is attended with much danger,‡ and the information given in doubtful cases can be more safely gained by a small exploratory abdominal incision.

The operation of cholecystotomy is usually performed in one stage. The anæsthetic should be chloroform followed, if needful, by A.C.E. Ether must be avoided in these cases, usually middle-aged, and often stout and flabby, and the subjects of chronic bronchitis. The abdomen having been cleansed (p. 667) and the parts relaxed, one of the following incisions is made use of. The best one is a vertical one, 3 to 4 inches long, either over the fundus if the tumour is prominent, or straight down from the tip of the cartilage of the tenth rib, or one in the right linea semilunaris; finally, in the case of those large and doubtful swellings due to distended gall-bladder, the incision should be made in the linea alba. The peritonæum being reached, any vessels which need it are secured with chromic gut. The peritonæum is then picked up and opened, and an index finger introduced to feel for the gall-bladder, to which calculi are often a guide. If there is difficulty in this stage, the liver edge should be used as a landmark.* Some trouble may be given now by the omentum or the intestines concealing, and perhaps adhering to, the gall-bladder, or by the liver, if enlarged, descending with respiration and requiring to be pushed up. The intestines must be kept out of the way by the use of carbolized sponges or a towel (p. 770). When the gall-bladder is found, the next thing is to bring it into the wound.† If this can be effected, any fluid contents are withdrawn with the aspirator to diminish the size of the swelling. The puncture being enlarged,‡ a finger is inserted to feel for calculi.§ Any that are well in reach are removed by small scoops or forceps (Fig. 135), while escape of any fluids into the peritonæal cavity is prevented by the careful packing of carbolized sponges or towels, and by an assistant keeping the edges of the wound in the abdomen and gall-bladder carefully together. Before extraction of any difficult calculi is attempted, the edges of the gall-bladder should be sutured to those of the abdominal wound with a continuous suture of carbolized silk, or with separate ones at short intervals, and intervening ones of horsehair or fishing gut. The parietal peritonæum must be carefully taken up, and the sutures passed at a sufficient distance from the edges of the gall-bladder and the incision in the abdominal wall to ensure a good hold. The sutures should pass through any bleeding points in the cut gall-bladder, and, as the stitches are inserted, the sponges are withdrawn. A drainage-tube is finally inserted and the dressings applied. These may require frequent changing at first. Mr. Mayo Robson (*loc. infra cit.*) advises the following method of suturing the gall-bladder as likely to prevent a permanent fistula:—The serous coat of the gall-bladder is sutured to the parietal peritonæum, and the mucous coat to the aponeurotic layer of the abdominal wall, thus leaving the skin and subcutaneous tissue free to granulate and close the opening.

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* As in cases where the mischief is not due to impacted calculi, but to atresia, &c., after ulceration.

† Mr. Willett's case (p. 856) shows, however, that a fatal result may be brought about by the constant, exhausting escape on the surface and the sores which it may produce.

‡ Thus in two cases (quoted by Mr. Greig Smith), in one of which Dr. Harley explored with a fine aspirator-needle, after a short interval, the patient died with enteritis and peritonitis. In a case of Dr. Keen's not a little hæmorrhage and considerable local peritonitis followed the use of a hypodermic syringe. Furthermore, the utility of this step is doubtful, for the point of the needle may easily miss the stone. Mr. Greig Smith condemns this step, and Mr. Meredith (*Dict. of Surg.*, vol. i. p. 284) considers it "not altogether devoid of risk." On the other hand, Mr. Morris seems to consider it safe, and quotes a case of Dr. Dixon's (*Pract.*, April 1876), in which the gall-bladder was tapped five times with great relief in a case of obstruction of the common duct with cancer, a total of 87½ oz. being withdrawn with the aspirator.

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* In one case of Dr. Parkes' (*Trans. Amer. Surg. Assoc.*, vol. iv. p. 299), in which there had been a two years' history of biliary colic, "the most careful and diligent search failed to find the gall-bladder, the proper location of which was plainly outlined and felt with the finger, with reference to the transverse fissure and ligament, showing the entire absence of the gall-cyst; but close to, and partly encroaching upon the transverse fissure was found an elevated, resisting tumour, the exact nature of which could not be determined, but probably containing biliary concretions." It was too near the large blood-vessels to admit of any interference with it. Post-mortem examination revealed remains of the shrunken gall-bladder, but with no sign of bile in it. A gall-stone lay at the junction of the hepatic and common ducts.

† Mr. Tait draws up the fundus of the bladder into the wound cautiously with a pair of forceps. Great care must be taken not to rupture a bladder much distended, or to cause sloughing.

‡ The escape of bile into the peritonæal cavity is prevented by packing sponges (previously counted) around the gall-bladder, and holding one under it in clamp-forceps.

§ In one case of Mr. Thornton's (*Brit. Med. Journ.*, 1886, vol. ii. p. 902), the majority of the stones—412 were removed—lay in the cavity of the liver substance. Through the liver tissue which presented in the incision stones could be felt moving on each other: the gall-bladder was small and atrophied; a large stone occupied the common duct. Here the large stone originally in the gall-bladder had become impacted in the common duct, the other stones being found in the hepatic duct and above it in the liver, where they gradually hollowed out a cavity.

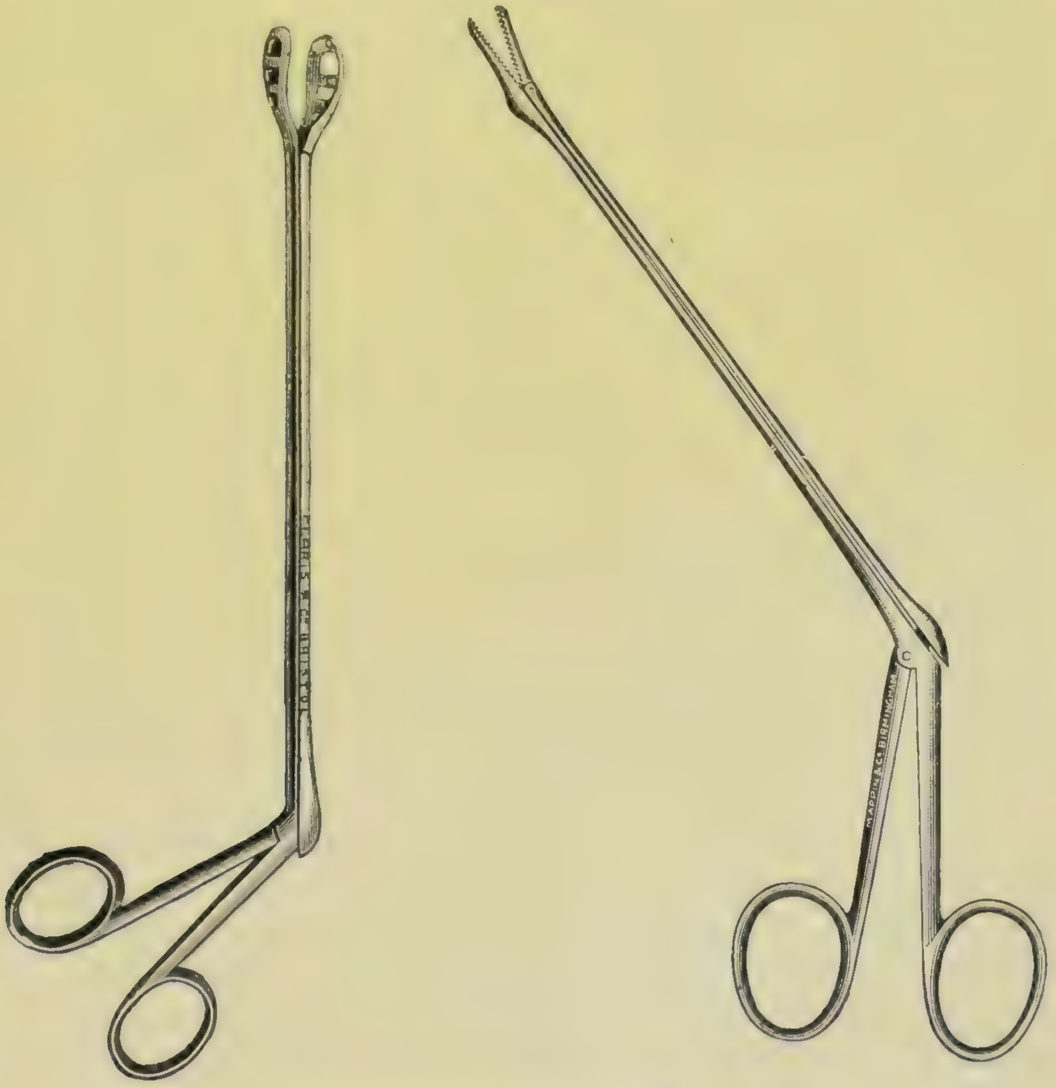
Some surgeons have preferred to open the gall-bladder by two stages, exposing it first and suturing it carefully to the edges of the wound, closing the angles of this exactly, and opening the gall-bladder a few days later.

A few points still require attention. The difficulty of finding the gall-bladder and of getting it up into the wound has been already referred to. In one case, in which Dr. Parkes (*loc. supra cit.*) met with this latter difficulty, owing to the thickening and matting of the gall-bladder, he detached some of its adhesions to the liver and passed a silk suture through opposite sides of the thickened fundus, as far from each other as possible. The gall-bladder was then opened by cutting between the sutures, and forty-three stones removed. The opening in the gall-bladder was then closed, leaving an orifice at the tip to insert a large drainage-tube, some of the highest sutures being passed through the abdominal wall.

Other courses which may be adopted in these cases, where it is quite impossible to get the gall-bladder up into the wound, are (1) to shut off the peritonæal cavity at the upper part of the wound by suturing the parietal peritonæum to the edges of the wound in the gall-bladder, and at the lower part to use the omentum as a plug by stitching it around the wound in the gall-bladder and to the parietal peritonæum after the drainage-tube had been introduced into the gall-bladder—this ingenious method was successfully adopted by Mr. Mayo Robson (*loc. supra cit.*, p. 14); (2) where the edges of the cavity from which the stones have been removed are irregular and friable and will not hold sutures, to pack aseptic sponges, frequently changed, around the drainage-tube—a plan adopted successfully by the same surgeon (*vide infra*, p. 857); (3) to perform cholecystectomy, as in Mr. Gould's case (p. 858).

Extraction of all the calculi is often most difficult, especially of any very far down in the cystic duct, or of such a one as Mr. Tait thus describes (*Lancet*, August 29, 1885). The stone was probably pear-shaped, and impacted at the orifice of the duct. "From the long, narrow, funnel-like cavity in which it was lodged, and from the mobility of the bladder, it was very difficult to seize, and, when at last I did get hold of it, I found it adherent to the mucous surface. I had then to consider the extreme likelihood that in removing this impacted stone I might tear the walls to which it was attached, and thus certainly kill my patient. I therefore performed a very careful and protracted lithotrity, chipping little fragments off the stone regularly all over its exposed surface, till I had the satisfaction of lifting out its nucleus. I then passed the blade of a fine pair of forceps on each side of it, and by a gentle squeeze broke up the remainder." Frequent

FIG. 135.



Tait's cholelithotomy forceps. (Greig Smith.)

washings out were then employed. While forceps are thus used, one forefinger is placed over the stone to guard the parts from undue violence, and to dislodge any fragments.

In another case of a stone which he could neither extract with forceps nor dislodge, the same surgeon very ingeniously crushed the stone *in situ* by means of carefully padded forceps applied outside the duct walls, and then dislodged the fragments by finger-pressure.

Where the extraction of stones is very difficult, Mr. K. Thornton (*Brit. Med. Journ.*, 1889, vol. ii. p. 983) advised breaking up the stone by needling it through the walls of the duct, and letting the fragments be afterwards passed to the duodenum. In one case he slit up the common duct, removed the stone, and then stitched up the duct. This, he allowed, was highly hazardous, but the patient recovered.

The resulting biliary fistula will probably close in a few weeks if the ducts are now pervious. Through it further attempts may be made to get rid of any remaining calculi.* If the wound, after closing, breaks open and discharges mucus, a stone is probably left behind in the gall-bladder.

If the fistula does not close, the continuous soakage, aided by the irritation-sores which it produces, may exhaust the patient, as in Mr. Willett's case (*Brit. Med. Journ.*, 1886, vol. ii. p. 903). Here in a woman, aged fifty-two, the annoyance was minimized as long as the patient was in the hospital, but death took place from the above cause some months later.†

In such a case the following courses are open:—(i.) To try to open up the common duct into the intestine by a steel sound, guided by a finger in the peritonæal cavity (Parkes, *Amer. Journ. Med. Sci.*, July 1885). (ii.) As Mr. Willett suggests, to make a communication between the gall-bladder and the intestine. Of the two sites which offer themselves, hepatic flexure of colon and junction of first and second parts of duodenum (as here a naturally formed fistula is nearly always found); Mr. Willett would select the colon, chiefly because this operation would be so much easier and safer, owing to the closeness of the colon to the gall-bladder, and as, if the duodenum were selected, the operation would be far more difficult, owing to the restricted space and the depth at which this part of the intestine lies. Nussbaum has advised making the communication with the jejunum, and Kappeler and Socin have each acted on the suggestion. The latter's case is mentioned in the *Brit. Med. Journ.*, 1888, vol. ii. p. 787. Mr. Mayo Robson (*Med. Chir. Trans.*, vol. lxxiii. p. 61) has published a case in which he successfully made a communication between the gall-bladder and the hepatic flexure of the colon. After the gall-bladder had been opened for empyema, a biliary fistula had persisted for fifteen months. The condition of the patient was a very miserable one, as no apparatus could be made to fit sufficiently accurately to catch the bile, save when the patient was in bed. The abdomen being opened through the old scar, in the centre of which was the fistula, the gall-bladder, "much thickened and contracted, was detached from the parietes. There was so much matting of the viscera that it was found impracticable to bring up and fix the duodenum and jejunum to the gall-bladder; hence the hepatic flexure of the colon, lying near, was raised and encircled by an elastic ligature,* after its contents had been squeezed upwards and downwards. Convenient spots having been selected on the gall-bladder and colon, a circle the size of a florin was marked by a scalpel on each. Along these lines sutures of fine chromicized gut were passed, about $\frac{1}{8}$ inch apart, but these were not tightened until openings $\frac{1}{3}$ inch in diameter had been made in the centre of the circles, quite through all the coats of the viscera concerned, and the cut edges of the mucous membrane of the colon had been sutured by interrupted sutures of fine catgut to the edge of the mucous membrane of the gall-bladder." The refreshed edges of the old fistula in the gall-bladder were then brought together by a continuous catgut suture, the serous surface being tucked in, and a number of Lembert's sutures being further applied over the line of union. The elastic ligature was removed from the bowel, and the circulation became immediately re-established. Packing in of sponges prevented any soiling of the peritonæum. A glass drainage-tube brought out at the lower end of the wound guarded against any accident of sutures giving way. Lastly the parietal incision was closed. Some bile escaped about twenty-four hours after, then bile and fæces, and finally bile alone. In two months the fistula was soundly healed. Mr. Symonds, at the debate on Mr. Robson's paper (*Brit. Med. Journ.*, 1889, vol. ii. p. 983), mentioned a case in which, owing to the large quantities of bile discharged, it had been necessary to make a communication between the gall-bladder and the intestine. Unfortunately, the opening into the bowel sloughed.

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* Mr. G. Smith (*loc. supra cit.*, p. 549) remarks that, if the gall-bladder is adherent to the abdominal walls, any stones which may subsequently form can be safely removed through the old scar.

† That this is not always the result of a biliary fistula is shown by a case of Dr. Money and Mr. Pollard's, in which, after removal of many stones, a fistula persisted for fifteen months. The man wore a rubber tube, through which 16 to 20 oz. of bile were daily discharged. He was able to do his work well.

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* This ligature consisted of a piece of drainage-tube, fixed by pressure-forceps. This prevented any escape of gas or fæcal matter, and rendered the intestine almost bloodless, simplifying the operation considerably hence Mr. Robson would prefer it to any other intestinal clamp.

While primary closure of the gall-bladder has been successful in a few cases, it is not so safe a method, and involves the risk of leaving one or more stones behind.

Difficulties of the Operation.

1. In this class of patients the anæsthetic (p. 852) may be taken badly. 2. A very large amount of fat, and thus a very deep wound. 3. Crowding up of the intestines. 4. Adhesions of omentum, &c., to liver. 5. The gall-bladder may be much thickened and tied down, thus difficult to find, and impossible to bring up into the wound. An excellent instance of the difficulties which may be met with here, and to which I have already alluded (p. 854), has been published by Dr. Pringle (*Lancet*, 1886, vol. ii. p. 1072). Mr. Pearce Gould was the operator. "On opening the peritonæal cavity, the liver was at once seen to be considerably enlarged, with a deep notch in its free border in the position of the gall-bladder, but that organ could neither be seen nor felt. The finger, when passed in deeply under the liver, felt a stone. The omentum and colon were protected and pressed down by a flat sponge, the edge of the liver raised, and a careful dissection made in the direction of the gall-bladder, which was exposed after dividing firm peritonæal adhesions. The bladder was small, did not reach the free border of the liver, and no stone was felt in it. An aspirator was introduced, and about 2 drachms of pale bile and mucus withdrawn. The puncture was then enlarged to admit the forefinger, but the stone could not be felt from the interior of the bladder. Repeated attempts to pass a probe into the cystic duct failed, nor could the stone be pushed back into the gall-bladder or into the intestine. It was then found to be quite impracticable to stitch the gall-bladder to the abdominal wound, and it lay so deep that an attempt to suture the wound in it was hardly more successful. Under these circumstances the fundus of the gall-bladder was freed from the liver, and a stout silk ligature was tied tightly round the bladder well beyond the wound, and the part incised cut off. The peritonæum of the stump was then stitched over the mucous membrane with fine catgut. The stone was now felt for again, and found to be very movable, at times slipping out of reach, so

that it was impossible to grasp it between the fingers or in a forceps, or to force it into the duodenum." All hæmorrhage having been stopped and the peritonæal cavity sponged out, the wound was closed. The operation lasted a little over two hours. The patient died, fifty-four hours later, of severe acute bronchitis, mainly due to the ether. Localized peritonitis was found in the neighbourhood of the wound, and some bile-stained fluid had escaped from the end of the duct, which was not completely closed by the ligature. In one case (Dr. A. Wilson, *Lancet*, 1886, vol. ii. p. 1218) the duodenum and adjacent parts were so altered and matted together by repeated attacks of peritonitis that it was found post mortem that what had been taken for the gall-bladder during life was really an enormously dilated cystic duct. In one of Mr. Robson's most interesting cases (*loc. supra cit.*, p. 2) the tumour on being exposed "seemed to be composed of liver, gall-bladder, stomach, and omentum matted together. No fluctuation could be made out, and the tumour seemed so firm, hard, and nodulated as to give the impression of being malignant. An exploring syringe pushed deeply into the swelling simply withdrew a little blood; but on pushing the needle through the overlapping edge of the liver, in the direction of the cystic duct, pus was withdrawn. On attempting to separate the liver from what was supposed to be the gall-bladder, pus began to well up, but fortunately none of it escaped into the peritonæal cavity, as sponges had been packed round the opening. On dilating the opening sufficiently to admit the finger, gall-stones were at once felt, one of which, about the size of a small walnut, was easily removed; the second, impacted in the cystic duct, broke in removal, leaving the distal portion still within the duct; this was removed with considerable difficulty, as, on account of the matting of the parts, the finger could not be passed beyond the cystic duct to aid in its expulsion; after its removal the index finger, on being pushed into the duct as far as possible, discovered another impacted stone, which it was found impossible to remove. As the sequel showed, this was perhaps rather a happy circumstance, for, on account of the depth, the friability, and the adhesions of the gall-bladder, it was found impossible to suture it to the surface, as the stitches would not hold; hence, after the suppurating cavity had been washed out with a solution of fluosilicate of soda (gr. 10—Oj) and a drainage-tube inserted, the upper and lower ends of the incision were drawn together by silk sutures so as to somewhat limit the opening. The peritonæal cavity was left freely open, two sponges being placed on each side the opening into the gall-bladder so as to absorb any discharge flowing out of it. They were at first changed every two hours, antiseptic precautions being adopted. At the end of two days they were removed, one being simply applied directly over the drainage-tube, so as to press the parietal peritonæum into contact with the visceral." The patient made a complete recovery. 6. The gall-bladder may be much shrunken, a smooth hard tumour being all that is felt in its situation* (p. 853). 7. A stone may be impacted very far back. 8. An enormous number of small stones.

CHOLECYSTECTOMY.

Extirpation of the gall-bladder was performed in five cases by Langenbeck, four being successful, and one fatal from ulceration of the bile duct brought about by an undetected calculus. Mr. Greig Smith thus writes of the operation :—"The indications given by Langenbeck are dropsy, cholelithiasis, and empyema. These indications are probably too broad. I should limit the indications to two—(1) where the bladder, containing one or more calculi, is so contracted that its fundus cannot be sutured to the parietes without tearing its walls; (2) where there has been perforation after ulceration and empyema, and the tissues are so thin or so much inflamed that they will not bear suturing. The operation need not be difficult. Separation from the liver is begun at the fundus and carried down to the cystic duct. This is divided between two ligatures, and the bladder removed. A suture passing through the outer coats will more thoroughly close the divided end of the duct. The incision will be at least 1½ inch longer than in cholecystotomy; if additional room is wanted, Courvoisier's plan of dividing transversely the muscles a little below the ribs may be adopted. If the bladder is intimately attached to the liver, a good deal of hæmorrhage may be expected; most of the bleeding may be checked by forcipressure, but a few ligatures may be called for. During the operation, the edge of the liver is pulled upwards by a retractor, and the area of operation is isolated by means of sponges."

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* In one case, published by Dr. Keen (*Philad. Med. Times*, November 14, 1885; *Ann. of Surg.*, January 1886), the gall-bladder being displaced, the duodenum was opened by mistake, and sutured. The gall-bladder was finally found far posterior to its proper site, much shrunken, and closely contracted over two gall-stones. The patient died, fifteen hours after the removal of these, from shock and a small amount of after-hæmorrhage, presumably from vessels injured in lifting to the surface the mass in which the stones were situated.

CHAPTER X.

OPERATIONS ON THE PANCREAS.

TREATMENT OF PANCREATIC CYSTS.

THE only operations on the pancreas to which I shall refer are those required for cysts of this viscus, as these alone are likely to call for surgical intervention. We owe our knowledge of the diseases of the pancreas to the exhaustive studies of Dr. N. Senn, of Milwaukee (*Intern. Journ. Med. Sci.*, 1886 and 1887).

Diagnosis of Pancreatic Cysts.—Sufficient cases have been published to make the following probably reliable:—The swelling, which may date to an accident, appears in an adult in the epigastric region, is generally accompanied (especially when its increase is rapid) by "cæliac neuralgia"—*i.e.*, pains probably arising in the solar plexus—often colicky, or even agonizing, and leading to collapse. Dyspepsia, marasmus, and mental depression are often present to a marked degree. The position of the cyst, behind the stomach and transverse colon, and the chemical and microscopical examination of the fluid are well worthy of attention.

Treatment.—Dr. Senn showed that the wisest course was incision of the cyst by laparotomy. The results of attempting to extirpate the cyst have been so unsuccessful as to entirely justify his condemnation of this course.

The following case, in which I operated at the request of my colleague, Dr. Newton Pitt, is a good instance of a pancreatic cyst treated by laparotomy, incision, and drainage. I received the following history when asked to see the case, August 21, 1889:—The patient was twenty-one. He had received a kick in the abdomen three years before, which had confined him to bed for three weeks. Ever since he had been liable to severe attacks of epigastric pain. He had been markedly jaundiced, was emaciated, and suffered a good deal from nausea and depression. The swelling in the epigastric region was convex and uniform, and reached from below the tip of the ensiform cartilage to just above the umbilicus, and laterally to near the tip of the eleventh ribs. The tumour gave the impression of being attached to some deep-seated structure. There was transmitted impulse synchronous with the pulse, but not expansile, as the swelling had refilled after two previous tappings,* and, as the swelling and the patient's distress were steadily increasing, laparotomy was performed, August 22, with strict antiseptic precautions. An incision, 3 inches long, was made over the most prominent part of the cyst, 1½ inch to the left of the middle line, extending to within an inch of the umbilicus. The parietal peritonæum having been stitched to the margins of the wound, the lower edge of the liver could be seen moving with respiration in the upper angle, while the rest of the incision was occupied by a smooth reddish surface, which bulged strongly forwards. Taking this to be the front of the cyst, and having ascertained before the operation that the cyst was dull on percussion, I was about to leave this, for twenty-four hours, to become adherent before it was incised. The result proved that, if I had done so, the scalpel would have passed through both walls of the stomach. Before dressing the wound, I again scrutinized the surface of the supposed cyst, and thought I found evidence of involuntary muscular fibre, which threw doubts upon the swelling being a pancreatic cyst. When the supposed cyst was examined between the fingers, it proved to be the empty stomach, stretched very tightly over the subjacent cyst. To get at this, the stomach was drawn upwards, that it might be packed away above under the liver. But here an embarrassing difficulty arose. As I pulled up the stomach, which was tightly jammed between the bulging cyst behind and the parietes in front, the omentum came up into the wound in front of the cyst. The tension of the parts was so great, owing to the rapid increase in the cyst, that there was no room above in which to pack away the omentum. Pushing this to either side, already fully occupied, pulled down the stomach again. I accordingly drew the greater part of the omentum out of the wound. Some of it was tied with catgut, and cut away; much of it was left heaped up on the abdominal walls on either side of the incision. One or two fine catgut sutures retained the omentum in position. I next scratched through the two layers of omentum, and exposed the surface of the cyst for a space the size of a shilling. There was thus a somewhat conical passage leading from the abdominal incision, through a mass of omentum, down to the anterior surface of the cyst. This last was very vascular, and so tense that it was not thought advisable to put in a guide suture. Iodoform having been dusted in, the wound was dressed with sal-alembroth gauze. The patient passed through the next twenty-four hours fairly well. At midnight, August 23, symptoms of collapse set in (hæmorrhage probably took place at this time into the cyst, a complication which must always be probable, owing to the very vascular surroundings of the cyst). His pulse at 2 A.M. had run up to 163, and his condition pointed to a fatal ending at no distant date. At 3 A.M. I passed a fine trocar into the cyst, and drew off 12 oz. of deeply blood-stained fluid, which was under very high tension. The sac was then incised and a large drainage-tube inserted. A marked improvement at once set in. A slight discharge of dark treacly fluid necessitated changing the dressing twice a day at first. The discharge was serous by September 12. I saw him in October soundly healed, just before he left for his home at Newcastle. All the omentum gradually shrivelled up, merging with the granulations around the wound.

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* The fluid was akaline, sage-green, sp. gr. 1013, albuminous, and, under the microscope, showing innumerable collections of globular masses of tyrosin crystals. No leucin could be detected. The fluid in these cysts varies a good deal—sometimes colourless and serous, at others it is red and viscid.

CHAPTER XI.

OPERATIONS ON THE OVARY.

OVARIOTOMY.—REMOVAL OF THE UTERINE APPENDAGES.

OVARIOTOMY.

ONE or two practical points will be alluded to before the operation itself is described.

Question of Adhesions.—If there is free mobility of the cyst from side to side, there are no parietal adhesions. In testing this, both hands should be employed. Does the tumour descend with a deep inspiration? Here a good light and careful percussion are needed. These movements are seen best when the surface of the cyst is uneven. Presence of intestine in front of the cyst can be made out by careful palpation and percussion. The history of pain (pointing to attacks of local peritonitis) and any previous tappings, together with the size and duration of the tumour, will also help in deciding as to adhesions. But it is often impossible, before the abdomen is opened, to say whether the operation will be easy or no.

Date of Operation.—The patient should be warned of the importance of an early one. The certainty of increasing adhesions and difficulty, the greater annoyance of the tumour (especially in unmarried women), the attacks of peritonitis with their pain, the risk of twisted pedicle and its results, must all be remembered. The patient must decide between living a year or two with the above risks before her and the growing misery of the tumour, and submitting to an operation the risks of which are but small, nowadays, in an average case which is taken early.

The condition of the viscera, kidneys, lungs, &c., *the habits of the patient*, her *amenability*, her *digestive powers*, must all be considered.

The *amount of skill of the surgeon*, though a delicate matter, must also be mentioned. No one should operate on these cases who has not had good opportunities of seeing others operate frequently, and no one should undertake a case whose ovariotomies are, at the most, likely to be but two or three in his lifetime.

Preparation of the Patient.—For a week before, the patient should be kept quiet, have a gentle aperient every other night, and a bath once in the twenty-four hours. The solids of the diet should be somewhat restricted, and all the food taken easily digested and nutritious. Sufficient fluids should be given to ensure a healthy clearing out of the kidneys, a little sound spirit, well diluted, being as suitable as any stimulant. If needful, one of the salts of lithia may be given three times a day. On the morning of the operation an enema should be given, a light breakfast taken early, and some good beef-tea or soup about 11 if the operation takes place about 2 P.M. When the patient, warmly clad, especially as to her extremities, comes in to take the anæsthetic, only two or three faces that are familiar to her should be present. It is best to begin with chloroform, but ether should always be at hand to go on with, save in those cases where the condition of the lungs is against this course. When the patient is under the anæsthetic, a catheter should always be passed, but not by the operator or any of his immediate assistants.

Preparation of Instruments, &c.—The room, which has been thoroughly cleansed, and not rendered too comfortless for the sake of ventilation, &c., should have a temperature of about 65°. A good light, and one likely to last, should be secured. The table should be sufficiently high to save the operator stooping, and only just wide enough to hold the patient comfortably. A dozen new Turkey sponges, chosen for their even softness of texture, should be thus prepared:*—All the sand is got out of them by beating them over a sheet or a towel, a process which requires to be repeated again and again by trusty hands. When they are really sandless, they should be placed in carbolic acid solution (1 in 20, and to be kept renewed), and in a solution of 1 in 40 for a few hours before the operation. During this they should be cleansed in a solution of the same strength. One or two flat ones (not too large) should be provided. A few small sponges ready for use on holders leave no excuse for the dividing of sponges during the operation, a course to be unhesitatingly condemned. It is well to record the number of sponges and Spencer Wells' forceps on a slate.

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* Mr. Doran (*Ann. of Surg.*, May 1888), in a very practical paper on "The Details of Ovariotomy," points out that, if the sponges are whitened as well as cleaned in a solution of sulphurous acid (1 in 5 of water), they will readily show any foreign matter clinging to them. He advises that a sponge be kept in Douglas' pouch during the operation.

The following should be in readiness:—Two scalpels; blunt-pointed bistoury; steel director; Key's director; at least six pairs of Spencer Wells' forceps; omentum clamp-forceps; cyst-forceps; Spencer Wells' vulsellum-trocar* and tubing; blunt-pointed scissors; needles, both twelve straight, two being threaded on each suture of stout silk for closing the abdominal wound, and fine ones, both straight and curved, for underrunning any bleeding point or introducing fine sutures if any of the contents of the abdomen are unavoidably injured; two aneurism-needles; plenty of silk and chromic-gut ligatures of varying sizes, and the material carefully prepared, including some stout enough for the pedicle; two pairs of dissecting-forceps; a probe; dressing-forceps; drainage-tubes, both glass and rubber; Paquelin's cautery; some solid perchloride of iron; abundance of carbolic and boracic acid lotion; a foot-pan to stand under the table; another to wash the sponges in; a laryngeal mirror or electric lamp. The instruments should stand, in two trays or pie-dishes, on a small wheel-table close to the operator's right hand; the ligatures and sutures should be in separate porringers, all covered with carbolic acid (1 in 40).

In addition to the anæsthetist, three assistants should be present—one to tie off vessels, &c., as they are taken up, help with the tumour, &c., another to keep the edges of the wound over the intestines if needful, and a third to hand instruments. Two nurses should be at hand to cleanse the sponges. Within reach of the operator should be a porringer of mercury perchloride solution (1 in 1000) for him to dip his fingers in occasionally. The abdomen of the patient should be shaved and cleansed (p. 667) just before the operation; mackintoshes are carefully packed around so as to cover all save the field of the operation, or the mackintosh with the oval opening bound with adhesive plaster may be used.†

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* One or two smaller trocars should also be in readiness.

† Irrigation should be used until the peritonæum is opened. After this the surgeon must rely on everything that comes in contact with the peritonæal cavity being made most strictly aseptic. The spray is said to render the operation safer in large hospitals, and to make effusions more harmless, and thus to diminish the need of drainage. On this point I have still grave doubts; the power of carbolic acid to render discharges innocuous is, I think, more than counterbalanced in abdominal surgery by its tendency to cause effusions of sero-sanguineous fluid during the first few hours after an operation. Its use should be certainly combined with extra carefulness in the "toilet." Finally, no amount of attention to antiseptic details will replace personal experience, fertility in expedients, and resourcefulness in meeting difficulties.

The Operation.—An incision,* reaching from just below the umbilicus to within 2 inches of the pubes, is made in the linea alba† rapidly down to the peritonæum. Before this is incised, Spencer Wells' forceps are applied to every bleeding point.‡ The peritonæum, readily recognized, when healthy, by its delicate fasciculation and translucency, is carefully hooked up so as to include nothing else, and opened. Occasionally large veins lie superficial to it, just in the operator's way. All bleeding must be arrested, especially at the lower angle of the wound. The peritonæum is next slit up on two fingers, to the length of the incision, and the pearly glistening cyst comes into view. The above applies to an easy case without parietal adhesions. But if the peritonæum is thickened and adherent to the cyst, there may be the greatest difficulty in deciding when this is reached. The best way to solve the doubt is to prolong the incision upwards to the left of the umbilicus, till a spot free from adhesions is found. While the operator is in uncertainty, on no account are apparent adhesions to be separated, or the parietal peritonæum may be detached from the abdominal wall. When the cyst is reached, it is examined with two or three fingers, which will give some information as to visceral and posterior adhesions. As soon as the cyst-surface is really made out it is best to tap it. To separate the adhesions before tapping it is, in Mr. Thornton's words (*Dict. of Surg.*, *loc. infra cit.*), "bad practice, because, if they are separated while the parietes and cyst-wall are both stretched by the fluid, all the little vessels in them bleed, and very serious hæmorrhage may occur out of sight during the subsequent emptying of the cyst; whereas, if the cyst be first tapped, the contraction of both parietes and cyst-wall closes the smaller vessels."

The cyst is tapped§ by carefully plunging in a Spencer Wells'

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[*] This should be from 2 to 3 inches long at first. Mr. Doran (*loc. supra cit.*) thinks a mistake is often made in not bringing the incision near enough to the pubes, which may cause much trouble when the pedicle has to be drawn out, and greatly impede a thorough exploration of the pelvis. With regard to wounding the bladder, the operator should trust neither to the position of the lower end of the wound, nor even to the catheter, but solely to the appearance of structures exposed.

[†] If the linea alba is missed and the rectus or pyramidalis cut into, the middle line will be found by pushing a probe inwards under or through these muscles.

[‡] Forcipressure should be trusted to as much as possible, the forceps being left on for five or ten minutes. Many ligatures weaken the cicatrix, and may cause actual suppuration.

[§] Great care must be taken to ensure all the fluid escaping well away from the wound, and, with sponges under the trocar, and by turning the patient on her side, to prevent any contamination of the peritonæal cavity. I have lately trocar, then guarding the point with the inner tube, and attaching the claws to the cyst so as to keep this on the trocar as forward traction is made. If it is clear from the bulk of the cyst remaining unaffected that it is multilocular* or solid, the surgeon must reduce it before attempting to extract it. If it be multilocular, it must be tapped again in two or three more places, by removing the trocar, and closing the puncture with cyst-forceps, and then, while the cyst is dragged forwards and steadied, the first trocar or a smaller one is thrust in at other spots where fluid is still present. This is better practice than thrusting the trocar from the first puncture into other parts of the cyst in the dark. If the bulk of the cyst be solid, the trocar puncture being enlarged, and clamp-forceps firmly keeping forwards the edges, the surgeon first introduces two or three, then perhaps all the fingers of one hand, and scoops out the solid material till the bulk of the cyst is sufficiently reduced to come through his incision. During the tapping one or two sponges must be kept under the trocar to prevent leakage into the peritonæal cavity.

If the wound requires enlargement, this is best done with a blunt-pointed, straight bistoury, and the use of two fingers as a director, the incision being carried to the left of the umbilicus so as to avoid any still open vessel in the round ligament. As the cyst comes forward any adhesions must be dealt with. The commonest are to the omentum, the small intestine, and transverse colon. The separation must be effected, bit by bit, with the finger-nail or steel director, each bleeding point being caught with pressure-forceps and tied. Another method is to under-run bleeding points, especially any obstinate ones in the parietal peritonæum. Any persistent oozing may be touched with Paquelin's cautery or the iron perchloride. Mr. Thornton thus advises the use of the latter :—" The surfaces to be touched should be dried with a sponge ; then a small sponge, well wrung, should be smeared lightly with the solid perchloride, and firmly pressed against the bleeding surface till the oozing stops ; a large flat sponge should be spread under the surfaces thus treated, to prevent any of the acid serum, which runs away immediately after

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(Jan. 1891) met with an unusual complication at this stage. Though the greater part of the tumour was clearly fluid very little could be made to escape through the trocar. The incision being enlarged and the cyst gradually brought outside numerous soft putty-like masses were found floating in the usual ovarian fluid. These had blocked the trocar. The upper part of the cyst was solid and contained the usual hair and teeth of a dermoid. The patient made an excellent recovery.

* If the cyst is multilocular, the largest should be first chosen (Galabin).

the application of the iron, getting on to the intestines. Oozing surfaces in the pelvis are treated in the same way, the intestines being first drawn out of the way and protected by sponges."

While adhesions* are being dealt with, the sides of the wound must be kept well approximated by an assistant, and a sponge placed in the lower angle to prevent fluid entering here. As the cyst comes forward, its posterior surface will either be free or attached to the small intestine. In either case the projection of any coils must be prevented by the use of a large flat sponge wrung out of mercury perchloride solution (1 in 2000), green protective, or a clean towel cut in two and soaked for half an hour in a 1 in 60 solution of carbolic acid.

When the cyst has been sufficiently brought outside, the pedicle is dealt with by the intra-peritonæal method.†

The centre of the pedicle being found by unfolding it, an aneurism-needle loaded with stout silk (No. 1) is made to perforate it here at a spot devoid of vessels. The loop of silk being drawn through and the needle withdrawn, the loop is cut, and the two ligatures tied firmly round the two halves of the pedicle. To make the silk hold in a stout pedicle, it is well to loop the ligatures round some blunt instruments, so as to tie them with sufficient force. When they are both tied, one is cut short, while the other is thrown round the whole pedicle and tied again. The cyst is then cut away not more than $\frac{3}{4}$ inch, and not less than $\frac{1}{2}$ inch from the ligatures. When this is done, the cut end is carefully examined, and any point that oozes tied with fine silk or chromic gut. The pedicle is then allowed to drop in, and the finger, following it down to the uterus, finds and hooks up the other ovary. If this is found enlarged, it must be removed. When the pedicle is very broad, a second or a third transfixion will be needed. The second must be thus performed:—The thread for the outer loop (*a*, Fig. 136) is twisted, on one side of the pedicle round the inner thread (*b*), then the outer loop is tied. The pedicle-needle (a long unhandled one with a large eye is the best) is then threaded, first with a single ligature (*c*), and then with one end (*b*) of the untied thread already passed through the pedicle. The transfixion is then performed (Fig. 136). The third thread (*c*) must be once twisted around the second (*b*); this is best done, perhaps, on the side where (*b*) forms a loop (Fig. 136). Then, on the opposite side, the two free ends of the second thread (*b*) are firmly tied. The ends of the third thread (*c*) are then tied on the inner side of the pedicle. The threads will then lie as in Fig. 137, firmly interlocked and holding the pedicle tightly. Should a third transfixion be required, the third thread, instead of being tied, must be threaded on the needle in company with a fourth, and the process just described repeated, care being taken to interlock the threads as before. If this precaution be not taken, the unlocked threads pulling in different directions will tend to tear the pedicle apart at the point of transfixion, and vessels may easily escape being commanded. As each of the above loops is tied, the ends of the thread must be cut short or needless confusion will be entailed.

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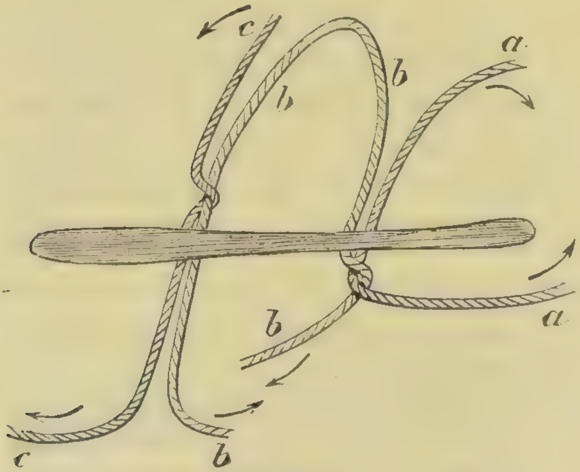
* Sometimes these are so broad as to require separation bit by bit, and the application of a pressure-forceps to each bleeding point.

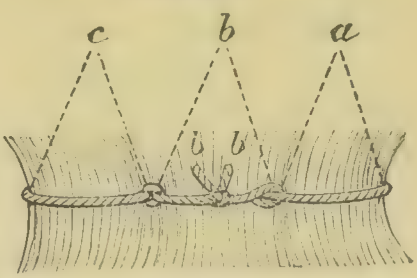
† Mr. K. Thornton (*Dict. of Surg.*, vol. ii. p. 155) thus describes the method of *enucleation* for cases with no pedicle:—"Cases are met with in which the base of the tumour is so situated between the layers of the broad ligament, or so pushes its way under the peritonæal covering of the uterus, or of the pelvic floor, that cautery and ligatures are alike inapplicable, or, at least, ligatures can only be applied after much previous enucleation. When this is the case, an incision should be made through the peritonæal capsule of the tumour, and careful enucleation practised with the fingers. It is well, if possible, so to direct this process as to isolate, at an early stage, the parts of the broad ligament which would form the pedicle in an ordinary case, and then to transfix and tie them in the usual way. After this, the chief blood-supply of the tumour is under control, and the rest of the enucleation may be more rapidly and boldly made. Shreds of capsule which bleed should all be secured in pressure-forceps, and ligatured with or without transfixion after the tumour is completely shelled out. Usually, the capsule falls together and no oozing occurs, but sometimes this is troublesome from a large surface, and Paquelin's cautery or the solid perchloride of iron may be applied [*vide supra*]. . . . . In performing these enucleations, the operator must always bear in mind the fact that the capsule is often the pelvic parietal peritonæum, and that he is consequently brought into dangerously close relations with bladder and ureters, rectum and sigmoid flexure, or cæcum and appendix (the latter is very frequently adherent in these cases), and, as it bleeds very much when torn, requires careful handling and often repair with a fine needle and silk. The large iliac vessels are also occasionally incorporated with the capsule."

FIG. 136.



(Doran.)

FIG. 137.



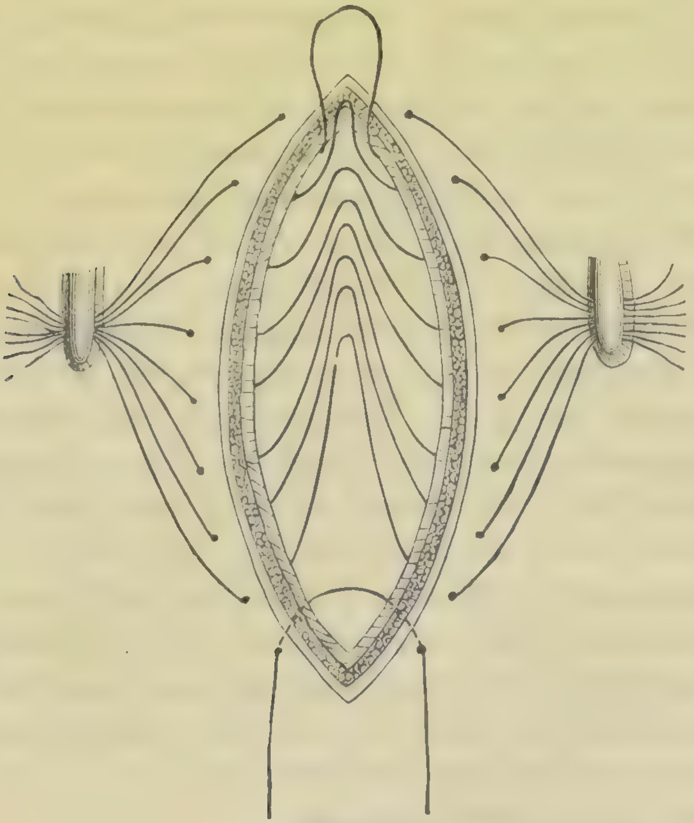
(Doran.)

The operator now scrutinizes the parts, removes any jagged omentum, arrests any still bleeding points, and takes out any sponges which he may have inserted, and has them all counted.

The next step is the "toilet," to sponge out most thoroughly the pelvis, the spaces in front of and behind the uterus, and those on either side of the vertebral column. This is effected by introducing again and again warm aseptic sponges, well wrung out, on clamp-forceps, until they return dry and colourless.

A flat sponge being now introduced to catch any blood, the abdominal wound is closed by means of sutures of stout silk with a needle at either end. Each needle is passed from within outwards through the peritonæum first, and then through the skin, at least $\frac{1}{4}$ inch from the edges of the wound. The sutures are inserted about $\frac{1}{2}$ inch from each other, and a few of horsehair may be put in quite superficially as well. Before they are tightened, the flat sponge is withdrawn. When they are all tied,* a little iodoform is dusted on, the abdomen cleansed, and dry-gauze dressings (sal alembroth or iodoform) applied.

FIG. 138.



(Doran.)

When all the threads have been introduced they are collected near their ends, on either side, with pressure-forceps (Fig. 138). The operator then parts the sutures, hooking them up and down, so as to obtain free access to the abdominal cavity without any risk of pulling out a suture. The flat sponge is now withdrawn, and the wound closed, or the peritonæal cavity wiped out with sponges, or "flushed" (p. 775), if needful.

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* They should not be tied too tightly, else points of suppuration will result.

The question of drainage* must depend mainly upon the completeness of the "toilet" of the peritonæum, the probability of any subsequent oozing, especially if deep in the pelvis, and the possibility of any septic fluid having entered the peritonæal cavity. A Keith's glass tube should be the one used, one end resting at the bottom of Douglas' pouch without pressing on the rectum, the other passes through a thin sheet of india-rubber, its neck being gripped firmly by a button-hole in this. It is well to pass one or two sutures, in the usual way, through the abdominal wound, above and below the tube, and to leave these to be tied when the tube is removed. Sponges charged frequently are placed over and around this end of the tube.

Incomplete Ovariotomy.—The surgeon may be compelled very early in the case to abandon his operation and to close the wound on account of malignancy, or of intimate adhesions between the cyst and important viscera. In other cases, having gone further, he may find the base of the cyst, whether encapsuled or no, irremovable, deep in the pelvis, and adherent to the ureter, large vessels, or adjacent viscera. The surgeon must then suture the cut edge of the base of the cyst and what remains of the capsule to the abdominal incision. Before doing this he must check all hæmorrhage, inspect any possibly damaged viscera, and cleanse carefully the back of the tumour and the parts behind it. If the abdominal wound is a long one, the upper part must first be closed by sutures (p. 871). The cut edge of the cyst must then be carefully sutured to the abdominal incision, the sutures being passed through the peritonæum, about $\frac{1}{4}$ inch from its cut edge, so as to bring it in contact with the cyst-wall. In doing this the peritonæal cavity must be entirely cut off from the wound. Adequate drainage must be provided. Mr. Doran points out that the operator must endeavour in these cases to remove all solid growth from the piece of cyst left behind, else both sepsis and recurrence will be very probable.

Accidents during Ovariotomy.

1. Fainting. This will be best met by preventive treatment.

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* Mr. Greig Smith's words should be remembered: "The question of drainage is a very difficult one to speak about in theory. In practice, a good rule to follow is—'When in doubt, drain.'"

If it occur during the operation, ether must be given, the head lowered and kept warm, and brandy given subcutaneously.

2. Vomiting. This chiefly harasses by straining the intestines out of the abdomen. If prolonged, the operation must be completed as soon as possible, an assistant keeping the abdominal walls pressed against the viscera, or dragging the former forward after pulling them between his finger and thumb.

3. Separation of the parietal peritonæum. This has already been spoken of, p. 867.

4. Rupture of the cyst. This accident may be expected when the walls are thin, rotten, or softened by recent peritonitis. In such cases careful handling, keeping suspicious spots well out of the wound or packed around with sponges, additional care with the "toilet," and irrigation with hot boiled water and use of a Keith's tube if any fluid has got into the peritonæal cavity, are indicated.

5. Injury to viscera. Of these the bladder, small intestine, rectum, and ureter are most likely to suffer. In the case of the bladder, the surgeon must decide, by the time of the injury and the amount of damage, as to whether he will complete the operation after closing the wound, or defer it. In the case of injury to the intestine the directions given at pp. 787, 802, will be found useful. In the case of the ureter it will usually be wisest to ligature the lower end, if possible, bring the upper out of the wound, and to perform nephrectomy subsequently, as in Simon's case.

6. Leaving in instruments—*e.g.*, sponge or forceps. The fact that this accident has occurred with operators of the largest experience should make all careful. It is best met by having a sufficient, definite number to begin with, counting carefully afterwards, and allowing no tearing of sponges (p. 865).

After-treatment.—I have no space for going carefully into details, but I should like to take this opportunity of saying that critical as the first forty-eight hours undoubtedly are, I believe there is often needless enforcing of rules. Less should be done in the way of frequent catheterism,* the amount of urine being now small, and less routine in the matter of morphia if the patient is not restless or wakeful, and less rigour in enforcing a dorsal position. During the above time little should be given by the mouth save cracked ice, and occasional teaspoonfuls of barley-water, or Valentine's meat-juice, with a few drops of brandy if required. Mr. K. Thornton advises the following enemata:—About six hours after the operation, or sooner if the patient be very weak, 3 oz. of strong beef-tea, just warm, and without salt, are injected into the rectum. This is to be repeated every three hours (every two if the patient is very weak), and every six hours twenty drops of laudanum are added. Before each injection, the female pipe of a Higgenson's syringe is placed in the rectum, with the bottom of an ordinary soap-dish under it, so that the flatus and refuse may pass away; it remains in ten minutes, and then the fresh injection is given.

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* On the whole I prefer a metal catheter with a single large eye. This can be kept in dilute carbolic acid, and, being shorter than a gum-elastic, there is less danger of its being pressed too far and thus causing irritation and most vexatious cystitis.

The chief questions that arise are, how best to act in threatening or actual peritonitis. Where only flatulence and some distension are present, they may yield to the passage of a long rectal tube, the injection of a pint of water, with or without turpentine, and the use of seidlitz powders. These failing, relief may still be given by the passage of a stomach-tube; and, if the vomiting and tympanitis continue, opening the wound below and irrigation of the peritonæal cavity with 2 per cent. of warm boracic acid lotion should be tried (p. 775).

REMOVAL OF THE UTERINE APPENDAGES.*

Indications.†—Before giving these, I would state that there is no operation in which it is more necessary to consider each case on its own bearings, to explain the object and results with honourable carefulness to the friends and, whenever possible, to the patient herself, and to remember that this is above all one of those operations which should never be entertained if there are any honest doubts as to the patient's health being really impaired beyond the aid of other treatment, and the impossibility of otherwise restoring her to usefulness in the position of life in which she has been placed. Finally, due weight must be given to the large part played by neuroses in this matter, and to the fact that till we have carefully published cases in which the results have been submitted to the only true test, that of time, we shall not be in a position to decide how far the after-condition of a great number of the patients who have been submitted to this operation, is one of improvement.*

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* This term has been used here for convenience' sake, as more comprehensive than "oophorectomy," &c. Moreover, it is as yet not certain whether removal of the ovaries without the Fallopian tubes will be sufficient to arrest menstruation.

† While these sheets are passing through the press a paper read at one of our Medical Societies and the discussion thereon has brought this matter prominently before the profession. I would strongly advise my younger readers to study carefully a very weighty letter in the journals of February 7, 1891, bearing the well-known signatures of Dr. John Williams and Dr. Champneys. Every sentence will well repay perusal. I quote a few. "Perimetritis is probably the very commonest of all the serious diseases of women. It is also perfectly certain that the great majority of cases get quite well without any operation. We are far from denying that exceptional cases call for surgical procedures, or that cases of prolonged suppuration in the pelvis are properly treated by the application to them of ordinary surgical principles. But this wholesale resort to a mutilating operation, advocated by several speakers at these discussions, calls for serious consideration by the profession. . . . . A plea for patience is to be found in the declaration of the operators that the full benefits of the operation are not felt for months or years after. If the operator would exercise this patience before the operation, there might be less need for its exercise by the patient after the operation."

The following carefully and wisely limited list of the indications for oophorectomy (Hart and Barbour, *Gynæcology*, p. 209) will commend itself. (1) *Intolerable dysmenorrhœa—i.e.*, where the patient has intolerable and prolonged pain every month, wearing her down, rendering habitual recourse to opiates necessary. "But as menstruation is not at first entirely arrested by the removal of the ovaries; and as we have always in such cases pelvic peritonitis adding to the patient's misery, and untouched by the operation, it is evident that we must not expect too much from it." (2) *Bleeding from fibroid tumours, uncontrollable by other means.* It is here that the operation has won some of its most brilliant successes. But Dr. Galabin's warning (*Dis. of Women*, p. 244) must not be forgotten: "Those varieties of fibroids which are liable to continue growing after the menopause—that is to say, soft, non-encapsuled fibroids, and fibro-cystic tumours—are likely also to be unaffected by oophorectomy. (3) *In some cases of hystero-epilepsy, convulsions, and threatened insanity, dependent on ovarian irritation or presence of ovaries with absence of uterus.* (4) *In some cases of ovaries prolapsed or fixed by adhesions*, giving rise to intolerable pain in coitus or seriously affecting the patient's health.

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* The following classification of possible indications for the operation (always subject to the above remarks) I have taken from Mr. Greig Smith, *loc. supra cit.*, p. 171. "A. THE APPENDAGES.—(1) The ovaries: (*a*) Inflammation—acute, chronic, and suppurative (abscess); (*b*) Displacement (prolapse, hernia); (*c*) Cirrhotic and cystic ovaries. (2) The Fallopian tubes: (*a*) Inflammation, salpingitis; (*b*) Pyo-salpinx; (*c*) Hæmato-salpinx; (*d*) Hydro-salpinx; (*e*) Fallopian pregnancy. B. THE UTERUS.—(*a*) Uterine myoma; (*b*) Errors of development—absence or mal-development of uterus with menstrual molimen; (*c*) Incurable displacements with severe nerve symptoms; (*d*) Insuperable obstruction to menstrual flow (may reside in vagina). C. THE NERVOUS SYSTEM.—(*a*) Mania, puerperal mania, menstro-mania, nympho-mania, &c.; (*b*) Epilepsy, hystero-epilepsy, convulsions, cramps, dancing fits, &c.; (*c*) Hysteria." Many will demur to some of the indications given under this heading. With regard to "puerperal mania," Mr. Greig Smith thinks that the operation is "especially indicated if the disease has occurred after a second confinement." With regard to "hysteria," even if associated with "dancing fits," all will agree with him that "the attacks would have to be very troublesome indeed, and the case would have to be surrounded with every conceivable inducement to operate, before interference could be contemplated."

Operation.—The following excellent account is taken from Mr. Greig Smith (*Abdom. Surg.*, p. 166):—

" *When the Appendages are Anatomically Normal,*[*] *or nearly so.* —The incision, made in the ordinary median position, need not be longer than 1½ or 2 inches—enough to admit two fingers easily. As the parietes are not thinned and distended by a tumour, the linea alba is very narrow, and it is not often that it can be divided without exposing one or both recti. A small opening is made in the fascia; if it is in the linea alba, well and good; if not, the layers are pushed to one side or the other, and, when the situation of the fibrous septum is found, the fascia is slit up to the length of the wound by the point of the knife cutting forwards. The muscular fibres are pushed to one side with the handle of the scalpel, and the sub-peritonæal fat exposed. This is caught upon two catch-forceps, and carefully divided between them. . . . . The peritonæum is easily recognized; a small opening is made in it while it is thus everted; the finger, inserted into this opening, acts as a director upon which the division is completed, preferably by scissors. By this method, which is Tait's, there is no danger of wounding the bowels; as each fold of tissue is pulled up and made tense, it is cut on its folded edge by the knife held horizontally; and when the very smallest opening has been made in the peritonæum the air rushes in, and the bowels, if they have been dragged forward by suction, fall back at once. . . . .

"The two first fingers are now inserted into the wound. If omentum covers the bowels, it must be dragged upwards; if not, the fingers are pushed straight down to the fundus uteri. The fingers, one on each side of the broad ligament, and grasping it between them, are now carried outwards till the ovary is felt; it is then lifted out of the wound[†] with its mesovarium and oviduct. Still held in this position with the left hand, the Fallopian tube is pulled out as far as it will readily come, and the pedicle spread out for ligature. The parts to be removed are the ovary with its mesovarium, and the Fallopian tube in its outer three-fourths, with the double peritonæal fold in which it lies, and which contains also the parovarium and the vascular erectile tissue known as the bulb of the ovary. The ligature is placed double by transfixing with a blunt needle. The inner pedicle contains the utero-ovarian ligament, the Fallopian tube somewhere near its isthmus, the spermatic artery and veins, and the small branch which accompanies the Fallopian tube. The outer ligature lies at the retiring angle where the infundibulo-pelvic and infundibulo-ovarian ligaments meet, takes its half of the mesovarium, and also constricts the spermatic artery. In most cases, no method of ligature is, in my opinion, superior to Tait's Staffordshire knot. . . . . The parts are then cut away by successive snips of scissors at a distance of about ⅛ inch from the ligature. Before making the last cut the surface must be carefully inspected to see that there is no bleeding. The pedicle is then dropped in. . . . . The same proceeding is then carried out with the appendages on the opposite side."

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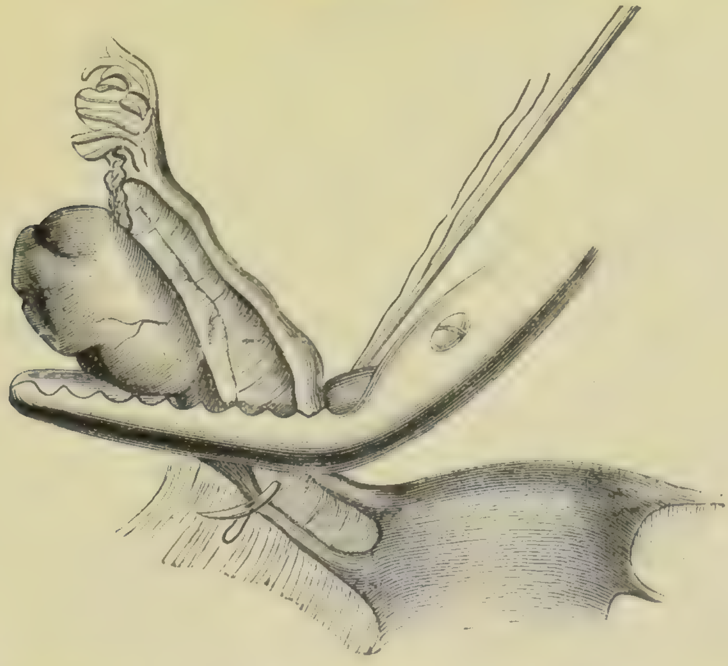
[*] By this I take the writer to mean not inflamed and adherent.

[†] Some difficulty will be met with now if the uterus is displaced backwards—viz., retroverted and anteflexed, as in a case of mine.

The wound is then closed as after ovariotomy (p. 871).

FIG. 139.



The appendages are grasped by large pressure-forceps. The pedicle-needle, bearing a loop of silk, perforates the broad ligament below the forceps and near the uterus. (Doran.)

"*When the Appendages are Inflamed and Adherent.*—The previous operation is a very simple one. . . . . But it is a very different thing if the appendages are adherent or inflamed, or suppurating or matted together, as in inflammatory diseases. Then the operation may be one of the most difficult in surgery. Even in the hands of surgeons of the highest skill, it has not infrequently been abandoned as impracticable. The first difficulty met with is, probably, that the appendages are fixed and cannot be drawn to the surface. They may be represented by an irregular conglomeration of cystic and cicatricial material, and sessile on the broad ligament or in Douglas's pouch, and perhaps intimately adherent to bowels. They are beyond the reach of sight, however much the abdominal walls are depressed. To deal with such a state of affairs one of two courses is open. The first is to enlarge the incision to 3 or 4 inches; to pull the bowels out of the pelvis, and keep them in the abdomen by one or more sponges packed under them; to pull the parietes apart from spatulæ, and seek by a strong light to expose the parts to view, and operate by the aid of light. This may be safe, but it is clumsy and difficult. If the parietes are muscular and firm, considerable force may be required to crowd the bowels into the abdomen, and to keep them there is still more difficult. . . . . The other course is that followed by Tait, as a result of his unrivalled experience. Tait has come to the conclusion that it is best to depend entirely on the fingers to deal with such a condition, relying on the skilled sense of touch to guard against the dangers of tearing bowels or other structures. To control bleeding he recommends sponge packing. First, the fingers map out the actual limits of the diseased organs; then these are gently separated from all surrounding parts, and gradually the mass is unfolded upwards from behind till the only attachment left is the proper pedicle of the parts to be removed. Even as thus separated, the appendages will probably be found sessile on the broad ligament, so that they can be little more than brought within the range of sight. The broad ligaments are stretched tightly across the pelvis, and dragging on the appendages may tear them. The pedicle ligature may have to be carried under the diseased parts at a considerable depth from the surface. If possible the tissues are gathered together in one pedicle, or by the Staffordshire knot; but the puckering produced may drag upon the opposite ligament so much as to cause tearing. To tie in two parts almost of necessity tears open the tissue between them. It has happened to me in one case, while pulling on a ligature, that the broad ligament was torn clean away from the side of the uterus for a distance of more than an inch. . . . .

"The bleeding in these cases is sometimes described as truly alarming, and I have had practical experience of this fact. Sponges are packed in everywhere as the adhesions are separated. If, after the appendages have been removed, bleeding still goes on, a little solution of iodine on a sponge may be applied to the raw surfaces. Of course, visible bleeding points are dealt with by ligature or forcipressure. And it may sometimes be good practice to leave forceps attached to bleeding points for twenty-four hours or so, their handles being left outside. In all such cases the insertion of a drainage-tube for a day or two is advisable.

"If abscesses exist, extra care is necessary to avoid rupture of the abscess-wall. It may be wise, before beginning separation, to aspirate the contents, and place a pressure-forceps on the opening so made. In such cases the placing of sponges all round the diseased parts is peculiarly necessary.

"*For Uterine Myoma.*—For small myomata the proceeding may be in no way different from the simplest operation. In fact, as the appendages are raised with the fundus, and the broad ligaments are usually soft and distensile, the operation may be rendered easier.

"When the tumour is large, and especially when it is adherent, the difficulties may be great, even insuperable. Not a few such operations begun as oophorectomy, have to be finished as hysterectomy. If the tumour grows away from the uterus, being subperitonæal and near the fundus, the appendages may be deep in the pelvis. Where the growth lies between the broad ligaments the ovaries will be elevated and squeezed between the tumour and the parietes. In an unsymmetrical growth one ovary may be quite conveniently near the surface, while the other lies out of reach and behind. Indeed, we must expect an endless variety of situation, and in some cases be prepared not to find ovaries at all.*

"When one ovary is found, we must, before proceeding to remove it, find the other; and before removing one we must be certain that it is possible to remove both. Having decided to remove the appendages, we rotate the tumour to one side so as to bring the parts first to be removed as close as possible to the surface. . . . . Thornton's plan of not cutting off the first ovary till all manipulations are over with the second is a good one; it minimizes the risk of bleeding from the divided pedicle."

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* Prof. Simpson (*Edin. Med. Journ.*, vol. xxx. p. 444) has practised with benefit ligature of the broad ligaments in cases where removal of the appendages has been found impossible.

CHAPTER XII.

OPERATIONS ON THE UTERUS.

REMOVAL OF MYOMATA BY ABDOMINAL SECTION.—REMOVAL OF A CANCEROUS UTERUS BY ABDOMINAL SECTION.—REMOVAL OF A CANCEROUS UTERUS PER VAGINAM.—CÆSAREAN SECTION.—PORRO'S OPERATION.

REMOVAL OF MYOMATA BY ABDOMINAL SECTION.

Indications.—These are thus laid down by the chief authority on this subject, Dr. T. Keith (*Hysterectomy for Fibrous Tumours of the Uterus*):—

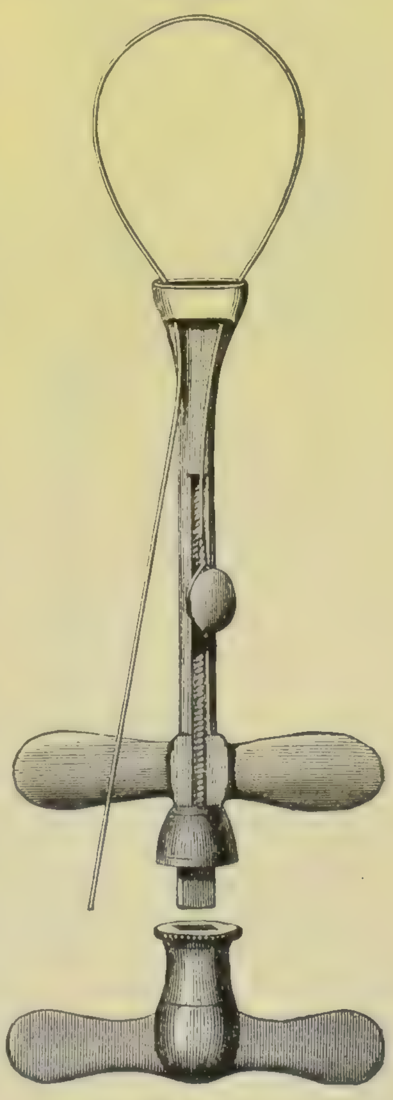
1. In very large rapidly growing tumours of all kinds in young women. By a large tumour is meant one of upwards of 20 lbs. 2. In all cases of real fibro-cystic tumours, if they can be removed; also in all cases of suppurating tumours. 3. In most cases of soft, œdematous, fibrous tumours. These often grow to an enormous size, far larger than any ovarian tumour. 4. In cases of large bleeding fibroids of any age, provided that the patient is not approaching fifty, that her life is practically useless, and that further experience in the operation shall show that the mortality of hysterectomy is likely to diminish. 5. In certain cases of tumour surrounded by free fluid, the result of peritonitis, provided that the fluid shows a tendency to re-accumulate after two or three punctures.

Mr. Greig Smith (*Abdom. Surg.*, p. 201) adds another—viz., where an operation with a view of removing the uterine appendages has been found impracticable, and examination proves that the myoma, with or without the uterus, can be removed; in such a case the major operation may be proceeded with.

Operation.—The preparations, &c., are much as have been given for ovariotomy (p. 865), but the following instruments will be wanted as well—viz., two clamps of Koeberlé's pattern, or Keith's large clamp, additional large clamp-forceps, and serre-nœud pins.

An incision is made in the linea alba from the umbilicus downward so as to admit the hand and examine the tumour. If it is decided to proceed, the incision is prolonged upward to the left of the umbilicus sufficiently freely to allow of the tumour being brought out without bruising of the incision or undue force. Any adhesions to the parietes or omentum, intestines or stomach being dealt with, the growth is lifted forwards by one or two of Tait's screws. This is often rendered very difficult if the lower part of the growth be firmly fixed in the pelvis. As it comes out the surgeon must take care that he is not pulling dangerously on viscera behind to which the growth may still be attached, and which he cannot see.* The relation of the bladder to the tumour must now be carefully made out. If the growth has extended into the pelvis or between the layers of the broad ligament, its connection with the bladder may be very intimate. Thus, the relations of the bladder must be defined, and, if needful, the two must be separated by careful dissection, a step made easier by not emptying the bladder before the operation, and by the passage of a sound.

FIG. 140.



Koeberlé's serre-nœud. (Galabin.)

The next step is to examine into the condition of the pedicle and to decide how to treat it. Of the two methods, intra- and extra-peritonæal, the former is now rarely used, owing to the risk of hæmorrhage from shrinking of the uterine tissue, or of sloughing and septicæmia.

Extra-Peritonœal Treatment of the Pedicle.—The following are the chief means employed :—

1. Wire constriction (Koeberlé, Tait). (Figs. 140, 141.) 2. Clamps (Keith). 3. Forcipressure and ligature of vessels (Spencer Wells). (Fig. 142.) 4. Elastic ligature (Martin and other German surgeons). 5. Enucleation.

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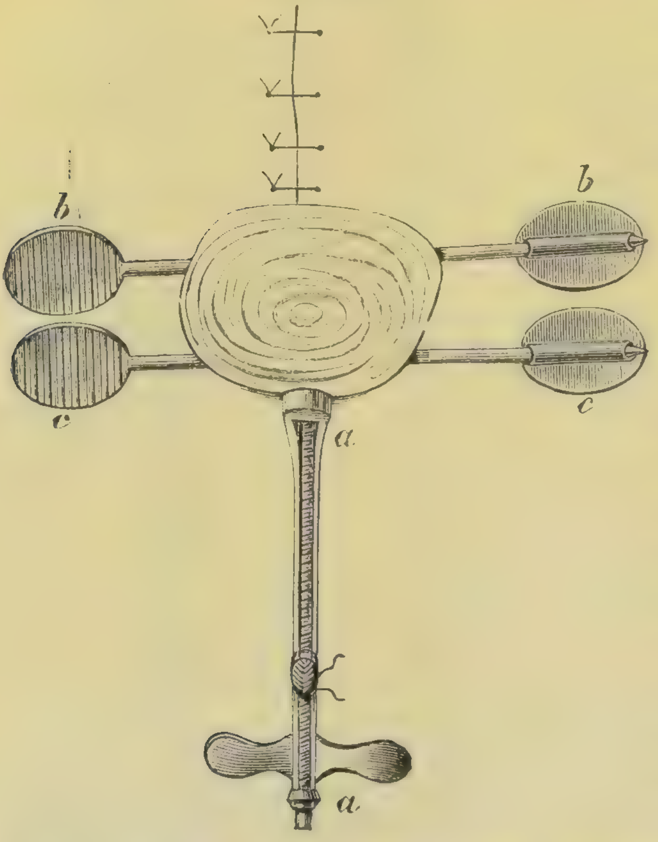
* Mr. K. Thornton (*Dict. of Surg.*, vol. ii. p. 746) points out that much more care is required in securing adhesions now, as a solid tumour allows of far more hæmorrhage than a collapsed ovarian cyst.

(1) *Wire Constriction.*—This is the form most usually employed. The loop is adjusted either round the narrowest part of the attachment of the tumour, or, if it be needful to open the cavity of the uterus, just above the internal os. If it be possible to include the appendages in the loop, this is done; in other cases the broad ligaments must be tied separately after transfixion. When the loop is tightened in position, it is screwed up slowly, for the shrinking of the tissues will allow of further tightening of the wire later on. One or two pedicle-pins are now thrust through the tumour just above the loop, it being intended that the broad and protected ends of these shall, by resting on the abdominal walls, keep the stump up in position. During the above steps sponges will have been applied so as to stop any fluids from going into the peritonæal cavity. Fresh ones are now carefully packed around, and the growth is cut away sufficiently beyond the pins to allow of paring down a little later. After this has been effected, the wire is finally tightened. The stump thus pared down, painted with iron perchloride or a strong solution of carbolic acid, and dusted with iodoform, is retained *in situ* by the pins and by the first of the sutures closing the abdominal wall, which is put in immediately above the stump.

FIG. 141.



The lower part of the abdominal wound is shown sutured above the stump. *a*, *a*, serre-nœud; *b*, *b*, pin passing nearer the anterior; and *c*, *c*, pin passing nearer the posterior boundaries of the stump. (Doran.)

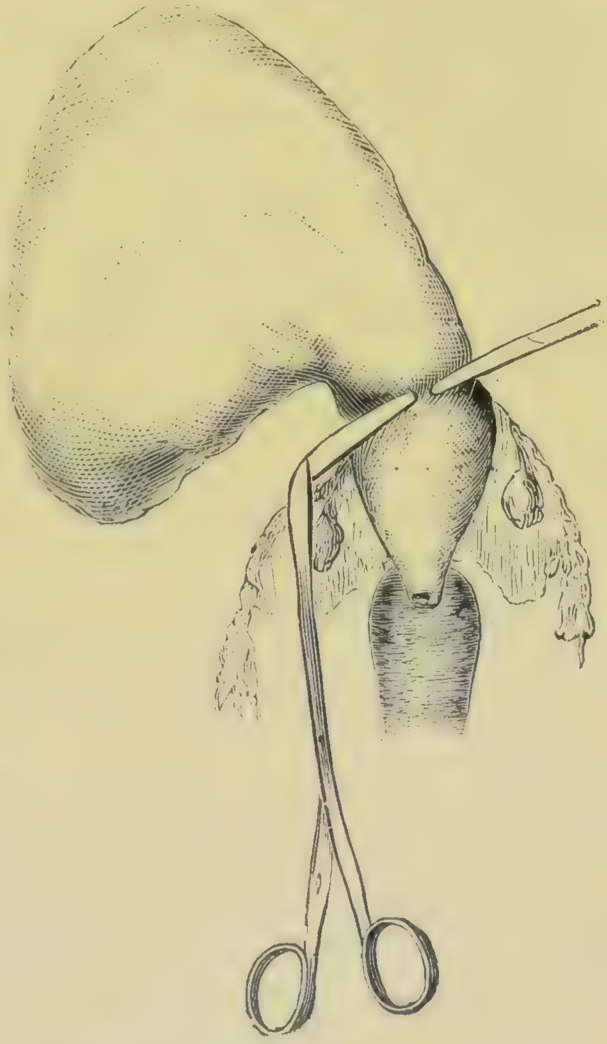
Any oozing points are now finally looked to, the peritonæal cavity cleansed, and the rest of the abdominal wound closed with the precautions given at p. 871. Dry gauze strips dusted with iodoform—these being distinct from those over the rest of the abdominal wound—are carefully packed around the stump, and some are placed under the ends of the pins.

The wire is tightened about every two days, fresh strips and the iron perchloride being applied as a little of the stump is clipped away.* If the wire has not made its way through in about two weeks, it may usually be removed at this time.

(2) *Clamp.*—Dr. Keith uses one of these made very large and thin, as likely to cause less sloughing than the wire, as it spreads out the pedicle more. The stump is treated in the same way as above given.

(3) *Forcipressure and Ligature of Vessels* (Fig. 142). — This mode of making temporary compression has been employed by Sir S. Wells with his powerful forceps. "Temporarily compressing the neck by two pairs of large forceps, as shown in the woodcut, the tumour was cut away about $\frac{1}{2}$ inch above the forceps. Transfixing between the points of the two forceps with a large needle carrying a double strong silk ligature, each ligature was tightened below the forceps, and, as the forceps were successively removed, the ligatures were still further tightened before the second knot was made. A third ligature was then applied close behind the other two. The peritonæal edges of the stump were then brought together by a few points of uninterrupted suture of fine silk." In other cases Sir Spencer has dispensed with ligatures,

FIG. 142.



Temporary forcipressure in the removal of a uterine tumour. (Spencer Wells.)

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* As this process is repeated great care must be taken not to cut into tissues which are still living. The tendency of the pedicle to sink back into a cone-shaped depression just above the pubes must also be remembered, the adhesions here remaining for some time very weak, and daily attention being required to keep the parts in a dried aseptic condition with iron perchloride and iodoform.

taking up the vessels with pressure-forceps, and tying them one by one as the large forceps were removed.

(4) *Elastic Ligature.*—This method has been largely used by German surgeons, especially Prof. Hegar, of Berlin. Dr. Lee,* of New York, thus describes its application. The base of the pedicle is surrounded "as low down as possible with Kleeburg's elastic ligature, which is tied while on the stretch. Above this a double ligature is passed through the stump, tied firmly in two sections, and all above that cut away. Now, drawing up this stump into the lower angle of the abdominal wound, the parietal peritonæum is stitched securely to the peritonæal covering of the pedicle, just below the elastic ligature. The first suture above the stump is passed through the parietal peritonæum, then under the elastic ligature, and through the peritonæum on the opposite side; when this is tightened, it closes in the stump with peritonæum completely. Two more sutures are passed just above this through the peritonæum only, and the rest of the wound is closed as usual. . . . . About the tenth day the elastic ligature is carefully cut away, and good union is obtained in a fortnight."

REMOVAL OF A CANCEROUS UTERUS BY ABDOMINAL SECTION.

This operation, introduced by Freund of Strasbourg, has been largely abandoned on account of its fatality. It is contrasted with the vaginal, and the indications are given later on, p. 888.

Operation.—The abdomen being opened in the usual way, as close down to the symphysis pubis as is safe,† the intestines are drawn out of the pelvis into the abdomen, and, if it be needful to get more room, are brought out and covered with carbolized towels kept warm (p. 770). The uterus is now caught with a powerful vulsellum, and dragged first to one side and then to the other, while the broad ligaments are transfixed by three ligatures which are made to interlock when tied. These are thus described by Mr. Thornton (*loc. supra cit.*):—"The first loop passes through the ovarian ligament and edge of the peritonæal covering of the Fallopian tube, and secures the ovarian vessels, the second loop passes through the round ligament and secures the pampiniform plexus. When the first two loops have been tied on each side, the ovaries and tubes are cut away, and the uterus is firmly drawn out of the pelvis, and a transverse incision is made through the peritonæum between the uterus and bladder; the latter is then peeled back,* and the incision carried through into the vagina. The uterus is then held forwards, and the peritonæum divided transversely behind to the same extent as in front, and the vagina opened into through the pouch of Douglas. The uterus is now merely held by small portions of tissue on each side, which contain the uterine arteries, and the third loop of the broad ligament ligatures is passed through on each side into the vagina, or from the vagina by a special curved needle, and tied round the tissues containing the uterine arteries; these small bridges of tissue on each side are then cut through and the uterus removed." Mr. Thornton recommends that, where the vagina allows of it, the uterus should be drawn out here, as less likely to contaminate the peritonæum and cut tissues with cancerous discharge than when it is taken out of the abdominal incision. Any bleeding points are now secured, a large T drainage-tube is placed in the wound with its central part brought out through the vagina. The edges of the cut peritonæum are then, as far as possible, united, the parts finally sponged out, and a little iodoform dusted in. The abdominal wound is then closed in the usual way. Prior to this operation the vagina must have been carefully cleansed by the precautions given below.

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* *Intern. Encycl. of Surg.*, vol. vi. p. 841.

† Dr. Lee advises partial detachment of the recti from their pubic insertion if the abdominal walls are very tense.

REMOVAL OF A CANCEROUS UTERUS PER VAGINAM.

Preparatory Treatment.—For some days before the external genitals are thoroughly cleansed, the vagina washed out with solution of carbolic acid or mercury perchloride, and a plug of iodoform wool inserted. If any very foul granulations are present, strong carbolic acid may be applied to them. The bowels are also thoroughly cleared out.

Operation.—The patient being in lithotomy position, supported by a Clover's crutch, the uterus is strongly dragged down with a vulsellum, sufficiently powerful, but with no larger handles than is needful. The parts are dilated for the surgeon by an assistant with a duck-bill speculum held posteriorly, by another dragging over the uterus as directed, and also by the left hand of the operator. With scissors, the mucous membrane is next cut through circularly, well clear of the disease. As Mr. Greig Smith remarks, the normal relations of the uterus to the bladder and rectum have been altered. The rest of my account is quoted from the above surgeon: "The mucous membrane is now elevated from the cervix, the connecting cellular tissue being divided by forefinger and scissors. A catch-forceps placed on the anterior flap and handed to the assistant, who pulls it forward while he depresses the cervix with the vulsellum, will facilitate the dissection in front, while a reversed manipulation will be of equal advantage behind. Laterally, no cutting must be made after the mucous membrane is divided. The cellular tissue must be pushed up as high as possible by the finger without tearing it; frequently the upward limit will be defined by a feeling of pulsation in the uterine arteries. . . . When the mucous membrane has been cleared from the cervix as high up as the peritonæum, that membrane is perforated in front and behind, and the abdominal cavity is entered. The forefinger is the best perforator. Above the internal os, the peritonæum is closely adherent to the uterus anteriorly and posteriorly, where the finger may be pushed through it by a little judicious manipulation. If it is more than ordinarily tough, and it seems to be yielding and stretching in front of the finger, a Lister's sinus-forceps sharply pushed through it will, after separation of the blades, make an opening large enough to admit the finger. The opening is enlarged in front and behind by tearing with the finger on both sides as far as the broad ligaments. A soft sponge is now pushed through into the posterior cul-de-sac and left there. It serves to protect the bowels and keep them out of the way, while it absorbs any fluids, and lies between the general cavity and any possible infection from the cancerous uterus."

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* During this a sound may be kept in the bladder.

The most difficult and delicate step in the whole proceeding is the separation of the uterus from the broad ligaments, and the securing of its vessels against bleeding. Mr. Greig Smith, having alluded to the endless variety of plans devised to meet this difficulty, thinks that the best and simplest means is afforded by a clamp which he has devised. It is a straight one, with long handles, and grooved laterally so as to guide a small knife in cutting through the clamped ligaments. It is thus employed:— "Through the posterior opening the forefinger is carried over the top of the broad ligament, hooking it down as far as possible. The posterior blade is now carried upwards along the finger at a distance of about ½ inch from the uterus, and the end looped over the top of the ligament. Its handle is pressed backwards on the perinæum. The anterior blade is introduced in front of the ligament, parallel to the posterior blade, and its end locked by a single mechanism. The clamp is then closed and screwed up tightly outside the vulva. A second clamp is similarly applied on the opposite ligament. A knife is run up the grooves and the ligament divided on the uterine side of the clamps, when the uterus is freed." The instruments may be easily removed at the end of two or three days, without hæmorrhage.

For cases unsuited for the clamps—*e.g.*, enlarged uteri—the same surgeon recommends the plan of turning the uterus upside down, and using forcipressure or ligatures. "Complete rotation of the uterus on its long axis materially shortens the depth of the broad ligaments, brings them more fully within the field of operation, and leaves the most important stage of the proceeding—division of the uterine arteries—to the last, when it is also rendered more easy. It matters little whether the uterus is turned backwards or forwards. If rotation can be performed by the finger alone, it is most easily carried out in the backward direction, with the finger in the posterior opening, hooked over the fundus. If the finger does not suffice, anterior rotation by means of forceps may be carried out. A firm hold of the anterior surface is taken hold of, and the uterus pulled down as much as possible; a second hold is secured higher up, and so on, one above the other, till the fundus is grasped, and the uterus pulled down and completely inverted. The fundus now lies in the vagina, and perhaps presents at the vulva, and the upper insertions of the broad ligaments are within sight and reach. . . . . With an inverted uterus, deligation of the broad ligaments presents no especial difficulties. First, a powerful Wells's forceps grasps as much as possible of one broad ligament, close to the uterus, and a strong silk ligature is carried round a corresponding depth of the ligament at a proper distance beyond. The intervening tissue is divided with scissors. Two or three successive pieces of ligaments are so treated, and one side of the uterus is set free. The other side is similarly treated, and the whole uterus is then removed. The broad ligaments are thus secured by three or four ligatures on each side, and they are cut short. If there is any doubt as to the security of the deligation at any point, a catch-forceps is placed on the visible vessels, or the forceps are left hanging, and removed next day or the day after. Ovaries and Fallopian tubes, if healthy, need not be removed. When the uterus is pulled down, and particularly if it is inverted, the broad ligaments are stretched and tense. As soon as the uterus is cut off, the ligaments recoil, become flaccid, and retract, tending to cast ligatures loose. Therefore these should be tightly drawn and should have a considerable hold upon the tissues. These precautions ought to be especially observed in the lower portions of the ligaments, where the uterine arteries lie. And it must be remembered that it is here where the risks of wounding the ureters, or of including them in the ligatures, is greatest. These dangers are enhanced by inversion of the uterus. They are minimized by a thorough separation of surrounding cellular tissue in the early stages, and by keeping always as close to the uterus as possible."

No sutures should be employed. As the sponge is withdrawn the flaps tend to fall together. A drainage-tube is inserted, and irrigation is practised by a catheter passed along this. Plugging of the vagina is thought unnecessary. The genitals must be kept scrupulously clean. If hæmorrhage occur, an anæsthetic must be given and the bleeding looked for and secured by forceps left attached. Oozing may be checked by syringing with very hot antiseptic lotions.

Contrast of the Abdominal and Vaginal Operations.—The former of these has been practically abandoned owing to its fatality, the mortality being about 70 per cent. Mr. Greig Smith (*loc. supra cit.*, p. 181) gives the mortality of the vaginal method as under 27 per cent. The dangers common to the two methods, shock, septicæmia, peritonitis, inclusion of the ureter, secondary hæmorrhage, seem to be better avoided by the simpler vaginal method. Mr. Greig Smith thus expresses his belief that, in carefully selected cases, the operation is both justifiable and proper. "The immediate mortality does not forbid it. Recurrence is almost certainly not more rapid than in other operations for cancer, and permanent recovery is just as likely to be secured. And, finally, there seems to be an almost unanimous opinion that death after recurrence is not attended with so much suffering, that perforations of bladder and rectum are not so liable to take place after the uterus is removed, and that existence is prolonged."

Mr. Thornton (*Dict. of Surg.*, vol. ii. p. 753) thus concludes his account of the operation:—"Time alone can decide whether complete extirpation of the uterus for cancer is destined to establish for itself a permanent place in surgery, or is to sink into oblivion again, as it has already done in the past, after a very decided attempt to establish it, though not on such a careful and scientific basis as in the present revival of the operation."

CÆSARIAN SECTION.*

The preparatory treatment is much the same as in ovariotomy. The same care must be taken to provide suitable sponges, pressure-forceps, and a sufficiency of sutures and ligatures.

An incision, about 5 inches long, is made as in ovariotomy, but does not descend within at least 2 inches of the pubes, for fear of injuring the bladder. Especial care must be taken in opening the peritonæum not to wound the uterus. If possible the placental site should be made out (a matter often of great difficulty) before opening the uterus, and avoided. The surgeon having decided where to incise the uterus, takes the following steps to prevent fluids escaping into the peritonæal cavity:—(1) By packing sponges (previously counted) carefully around. (2) By an assistant keeping the parietes firmly pressed against these and the uterus. (3) By another with his hands behind the uterus causing it to protrude into the wound, and firmly holding it there.

An incision 4 to 5 inches long is then made in the uterus, first by an incision partly through in the upper part, which is completed with the finger, and then by carrying this downwards with scissors. The hand being rapidly inserted partly closes the opening and finds the neck of the child, which is extracted head first.† All this time the entrance of blood and amniotic fluid must be prevented by the above-given precautions. The cord being divided between two pairs of Spencer Wells' forceps, the surgeon attends next to the bleeding and the placenta. If the uterus is contracting well, hæmorrhage will cease and spontaneous detachment will take place. If there is no time to wait for this, the placenta must be carefully peeled away while bleeding sinuses are compressed with sponges, or, if needful, with Spencer Wells' forceps.‡

The most important step, closure of the uterine wound, remains. The membranes being removed and the uterus contracted, superficial and deep sutures of carbolized silk are then inserted by the Sänger-Leopold method, which relies upon the peritonæum

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[*] I trust that in including the following short account of this and the following operation I shall not be met with the criticism "*ne sutor ultra crepidam.*" My excuse would be that these are operations which, in the country especially, any hospital surgeon may be sent for to perform, and that without much notice.

[†] If the feet are taken first, the uterus may contract around the head.

[‡] A hypodermic injection of ergotin may be given, and the uterus firmly grasped.

for the most perfect closure of the uterine wound. It is thus described by Mr. Greig Smith:—"The peritonæal covering is detached from the muscular fibre for a little distance along the margins of the wound: in this way it is possible to turn inwards a greater surface of peritonæum. Then the deep sutures are placed. They are made to enter about ½ inch from the edge of the wound, passed obliquely through uterine tissue, and made to emerge near the bottom of the cut surface. No suture should enter the uterine cavity. These deep sutures should be placed about ¾ inch apart; and they should be carried, converging a little, beyond the ends of the incision. Then the superficial sutures are placed, two between each deep suture. The needle first pierces peritonæum and muscle, coming out a little below the lip of the wound; then it picks up the free edge of the peritonæum on its own side, and finally pursues the same course in the opposite direction with the other side." These, also, are carried a little way beyond the margins of the wound. The superficial are first tied, then the deep. Finally, if apposition is not perfect, a few more sutures, or a continuous one, may be used. While the sutures are being inserted fresh sponges may be introduced. The peritonæum is then most carefully dried and cleansed. Drainage should be used, as after ovariotomy, if there is any suspicion of fluids in the peritonæal cavity. And if much oozing has taken place from the uterine walls, or if the discharges are foul, a tube should be passed from the uterus into the vagina before the sutures are passed. While the abdominal wound is being closed, an assistant syringes out the vagina with a Higgenson's syringe, and plugs it with iodoform or sal-alembroth gauze.

PORRO'S OPERATION.

By this is meant a Cæsarian section followed by removal of the uterus, together with its appendages, leaving only its cervical portion. The preparations are the same as for ovariotomy and Cæsarian section (*vide supra*). The parietal incision should be brought lower down than in the latter operation, as the uterine stump has to be brought out below. As the uterus will be amputated the uterine wound may be made by tearing or cutting, transversely or longitudinally, the selection of the site being made chiefly by the position of the placenta. The details, given at p. 889, for shutting off the peritonæal cavity should be scrupulously followed. The child being delivered, and the cord tied between compression-forceps, any bleeding which is not arrested by uterine contraction may be controlled by grasping the neck of the uterus with the hand, or by large T-shaped compression-forceps applied to the edges of the uterine wound. The uterus being delivered, the peritonæal cavity cleansed and again shut off with fresh sponges, the loop of the serre-nœud (Fig. 140) is placed at the level of the internal os, care being taken that both ovaries and tubes lie on the distal side of the wire. As the position of the internal os will vary with the stage of labour, Mr. Greig Smith advises that the wire be placed immediately below the bulge of the uterine walls, which marks the lowest descent of the fœtus. Two pins are then made to transfix the uterine tissues as in hysterectomy for fibroids (p. 141), and about ½ inch above the wire. The uterus is then amputated above the pins. The operation is completed much as in hysterectomy (p. 882). Before the pedicle is secured *in situ*, the internal cavity should be finally cleansed. If there be time it will be well to suture the parietal peritonæum to that surrounding the pedicle. The after-treatment is as in hysterectomy (*q.v.*)

Operations allied to that of Porro.—There are several of these, all performed on a pregnant uterus, but not preceded by Cæsarian section.

(i.) Total amputation of a pregnant uterus, Porro-Freund's operation. Here the entire uterus is removed by cutting through its connections with the vagina. Sir S. Wells has performed this operation successfully on a patient, aged thirty-seven, six months pregnant, with epithelioma of the cervix. The patient died thirteen months afterwards, having enjoyed good health for eight or nine months (*Abdominal Tumours*, p. 172).

(ii.) Supra-vaginal hysterectomy during pregnancy.—This has been done in cases of a pregnant uterus complicated with fibroid disease, before the fœtus is viable.

(iii.) Supra-vaginal hysterectomy for rupture of the uterus: with removal of the fœtus from the abdominal cavity.

(iv.) Laparo-Elytrotomy. Thomas's operation.—Here the upper part of the vagina is reached by curved incision parallel with and about ½ inch above Poupart's ligament, usually on the right side, as more remote from the rectum. The peritonæum is pushed upwards, the fœtus being removed by an incision in the outer and lateral aspect of the vagina. Thus the peritonæal cavity is not opened (not a matter of much importance nowadays) and the fœtus has not to pass through a contracted pelvis. Either Porro's operation or the Cæsarian section is simpler, and likely to be preferred.

CHAPTER XIII.

OPERATIONS ON THE BLADDER.

REMOVAL OF GROWTHS OF THE BLADDER.—OPERATIVE TREATMENT OF TUBERCULAR ULCERATION.—PARTIAL PROSTATECTOMY. — LATERAL LITHOTOMY.—SUPRA-PUBIC LITHOTOMY.—MEDIAN LITHOTOMY.—LITHOTRITY AND LITHOLAPAXY.—REMOVAL OF STONE IN THE FEMALE.—CYSTOTOMY.—RUPTURED BLADDER.

REMOVAL OF GROWTHS OF THE BLADDER.

Practical Points in the Diagnosis.—Indications for Operation.—Early and accurate diagnosis is here of the utmost importance.

I. *Hæmorrhage.*—This is of much importance, both in diagnosis and as bearing upon an operation. Thus in the villous growth or fimbriated papilloma it is this alone which kills. Again, it may be the only symptom. In these growths the chief point is that the hæmorrhage extends over a long time,* occurs spontaneously and suddenly, and without any allied symptoms; it ceases in the same way; the periods of intermission gradually become less, till the bleeding is constant, either rendering the patients utterly anæmic or adding to their misery by bringing about cystitis. These last two conditions may be so marked as to demand an operation. This symptom is most frequent in the villous growth (fimbriated papilloma),* less so in the fibro-papilloma or in the "transitional" growths. Sir H. Thompson lays much stress on the fact that, in these cases, the stream often begins without or with little blood, and ends of a bright-red colour. Again, if the bladder be washed out with an aseptic lotion (p. 918), this becomes deeply coloured after a very momentary stay within the viscus.

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* Mr. R. Harrison (*Intern. Encycl. Surg.*, vol. vi. p. 38) states that in the museum of St. George's Hospital there is a specimen of a villous tumour attached to the neck of the bladder of a gentleman aged eighty-one. The first attack of hæmorrhage had occurred twenty years before death, and had lasted for eight months, an interval of four years had followed this, and then a recurrence of hæmorrhage, which ultimately proved fatal. Sir B. Brodie also states that the disease occasionally extends over seven or eight years. In a case of Mr. Anderson's (*Clin. Soc. Trans.*, vol. xviii. p. 313), of papilloma, the first hæmaturia had taken place twelve years before, then came an interval of a year, followed by recurrence of the hæmaturia, the next interval being shortened to six months, after which recurrence took place fairly regularly every three months

II. *Sounding.*—This is usually said to be negative, but it should be made use of thoroughly and carefully. In the case of a single fimbriated papilloma, the sound may give no information unless it happen to detach the growth. In more solid growths—*e.g.*, a fibrous papilloma, a transitional or sarcomatous tumour—irregularity or resistance may always be met with at one spot in moving the sound.† In the mucous polypi of children any movements of the sound may be prevented, and carcinomata, if ulcerated, may give a very distinct, uneven, rugged feel, while the increase of pain afterwards is here very marked. But sounding is of value beyond what it tells at the time. By using the sound with judicious and gentle vigour, particles of a villous growth may be detached for microscopical examination. This may perhaps be aided by washing out with a lithotrity-evacuator as suggested by Mr. Davies-Colley. Several surgeons, I amongst the number, have had cases in which a catheter with large eyes has entangled and detached, as the bladder emptied, processes of the growth. Additional knowledge may be gained by the sensation sometimes given by the catheter as if it were moving against wet wool or sponge, or through delicate seaweed. Every precaution must be taken not to cause cystitis or to set up bleeding by the use of the catheter. If the latter follow, the bladder should be opened without delay. M. Guyon (*Ann. de Mal. des Organ. Gén. Ur.*, 1889, p. 449) points out that in a few cases a pedunculated growth situated near the neck may cause obstruction and other micturition troubles, before hæmorrhage appears.

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* Sir H. Thompson (*Tumours of the Bladder*, p. 66) thus classifies growths of the bladder:—1. Simple mucous polypus or myxoma; 2. Papillomata—(*a*) Fimbriated papilloma or villous tumour, (*b*) Fibro-papilloma; 3. Transitional tumours, intermediate in structure between the foregoing and the sarcomata; 4. Sarcomata, round and spindle-celled (rare); 5. Scirrhous, encephaloid, and melanotic cancers; 6. Dermoid tumours (rare). A more scientific classification is that given by Prof. Küster in Volkmann's Clin. Lect., *Annals of Surgery*, September 1886:—A. New growths of the prostate—1. Fibro-adenoma, 2. Myxoma, 3. Carcinoma. B. New growths of the bladder—i. New growths from the mucous or sub-mucous coat: 1. Papilloma (including the two varieties of Sir H. Thompson), 2. Fibrous polypi and myxoma, 3. Sarcoma; ii. New growths from the muscular coat: 4. Myoma; iii. New growths from the epithelial and glandular tissues: 5. Adenoma; 6. Carcinoma.

† Thus it may be easy to explore one side of the bladder by carrying the sound over to the opposite thigh, while similar manœuvres to examine the other side are interfered with.

III. *Examination of Urine.*—This aid has been too much neglected because the naturally present "transitional" epithelium of the bladder may so easily be mistaken for growth-cells. But in the case of villous growths especially, careful examination of the urine should be frequently made, and the patient directed to bring, at once, any white or shreddy particles passed. The sediment of the urine should be also frequently examined microscopically after sounding and washing out. The delicate papillæ, with their connective-tissue basis supporting hosts of columnar cells with large delicate capillaries, are most characteristic.

IV. *Examination per Rectum.*—This is usually negative. Occasionally pain, a tender spot, or thickening felt through the trigone, may point to the position of the growth. In elderly men a rectal examination should always be made to find out if any enlargement of the prostate exists. M. Guyon (*loc. supra cit.*) advises that with this examination should be combined bimanual pressure above the pubes. If this shows the bladder walls to be supple, soft, and mobile, any growth present is, probably, not malignant. In women the finger may be in the vagina or in the bladder through the dilated urethra, instead of in the bowel.

V. *The Cystoscope.*—In certain obscure cases, as where a growth is present for some time without causing bleeding, this instrument will be of much service. But, as a rule, the diagnosis of bladder-growths can be made without it. Nor may it be forgotten that its use entails certain disadvantages. Thus it may excite bleeding, it may cause grave febrile disturbance; one case has been related to me, in which difficulty of manipulating it through the prostatic urethra was followed by fatal injury to this part. Such cases are not published. While in the hands of a few of exceptional experience this method will be of great service, in the greater number any obscurity present will give way to other methods.

To those who are using it for the first time, the following fallacies in electrical cystoscopy, which have been pointed out by Mr. H. Fenwick (*Electrical Illumination of the Bladder and Urethra*, p. 94), will be useful:—

(*a*) *Healthy Bladder.*—(*a*) Mouth of ureter. This usually appearing as a pouting orifice, may be seen as a red cone, very like a sessile tumour. (*b*) Rugæ. These, if seen in profile, may resemble rows of papillomata. (*c*) Deposits of urates or phosphates. (*d*) Deposit of altered blood. (*e*) Mucus.

(β) *Diseased Bladder.*—(*a*) Rugæ. The resemblance of these, when inflamed, to papillomata is much increased. (*b*) Polyhedral projections of mucous membrane. These, when inflamed, may suggest myxomatous polypi. (*c*) Growths encrusted with phosphates closely resemble stones. (*d*) Sub-mucous hæmorrhages. These, met with in some cases of cystitis and tuberculosis, are very similar to epitheliomata. (*e*) Tuberculosis.* This more than any other disease is likely to lead to mistakes. First, the projections of swollen mucous membrane mimic papillary fibromata. Secondly, the tag-like streamers of necrotic tissue resemble the shreddy villi of neoplastic surfaces. (*f*) Enlarged middle lobe of the prostate. There is often much difficulty in telling whether this is simple or malignant.

VI. *Exclusion of other Conditions—e.g.*, stone, tubercular and other forms of cystitis, also hæmorrhage from the prostate or kidney. In none of these cases, save in the last, is there the spontaneous character which often marks the bleeding of bladder growths. In renal hæmaturia due to growth the bleeding may be spontaneous, and unaccompanied by other evidence. Here the renal region should be thoroughly examined at regular intervals. In tubercular disease of the bladder the bleeding is never as large as in growth, and for a long time occurs with the end of micturition. Other evidence will also be present, and so too with the hæmorrhage of enlarged prostate, which will very likely be preceded by a chill or by retention.

VII. *Failure of Previous Treatment.*—Growths of the bladder being inevitably fatal, whether from hæmorrhage, or pain, or obstruction-results, or from these combined, the surgeon is entirely justified in urging a digital exploration to clear up the case and the question of removal. While it remains as yet uncertain how many of the cases published as cures are really and permanently so, even in the case of the villous growth, it is an undoubted fact that an operation may result in arresting the hæmorrhage completely for years. In other cases, hæmorrhage, pain, and frequency of micturition may all be very largely relieved. Where little or nothing can be done in the way of removal, the free escape given to the urine by a perinæal or supra-pubic operation, or by dilating the neck of the bladder in a woman may give great relief; where even this fails, the case has, at least, been cleared up. For the great majority of cases the supra-pubic method is indicated, owing to the tendency of the perinæal opening to close.

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* Mr. Fenwick advises that cystoscopic examination should be dispensed with whenever it is possible owing to the tendency of these cases to resent instrumental interference. He also avoids cystoscopy in cases of irregularly enlarged prostates, and some much rarer conditions (p. 208).

Choice of Operation.—Where the surgeon is uncertain as to the size or the number of growths, where the perinæum is very deep, where the prostate is enlarged, or the perinæum small and the pelvic outlet contracted, the supra-pubic method will be safest and give most room. So, too, in the case of a recurrent growth, this method should be employed, as it cannot be told how far the recurrence is widely diffused.

If there is strong reason to believe that the growth is single, or small, or near the neck, the bladder may be explored from the perinæum by opening the membranous urethra, and dilating the vesical neck.

In some cases it will be advisable to combine both operations, as the perinæal opening enables the surgeon to use two index-fingers in the bladder at the same time, and also favours drainage.

In cases where, owing to complete removal, this has been an impossibility, it is desired to give relief by a permanent opening, a supra-pubic one kept patent on a short curved tube and plate (somewhat like a tracheotomy tube) will be preferable to a perinæal opening,* owing to the tendency of the latter to close.

Operation.—If the surgeon decide to first open the membranous urethra for purposes of exploration or to ensure drainage, he does so in the manner of a median lithotomy (p. 925), and explores the bladder after dilating the neck with his finger, which is made to enter by a careful insinuating movement along the director, which is then withdrawn. If no growth is felt near the neck, the surgeon, rising, makes firm supra-pubic pressure, so as to bring the upper part of the bladder into contact with his left index. On finding a growth, he carefully ascertains its size, situation, shape, existence or not of a peduncle, and whether this peduncle is narrow or not. Its structure is also examined, whether polypoid and firm, or soft, floating and villous.† If he decide that the growth can be removed by the perinæal wound, he must be provided with appropriate forceps, especially the ones with serrated edges, straight, and of different curves, introduced by Sir H. Thompson. Sharp spoons or scoops, curettes made with a flexible stem and thus capable of being bent to different angles, are very useful; a very small écraseur with violin-string ligature may perhaps be helpful. Sir H. Thompson* thus describes the use of the forceps:—Having, with his forefinger, first made himself familiar with the exact position and size of the tumour, the surgeon inserts the forceps, guided only by the knowledge thus acquired, and makes a decided snip on the tumour; then, by moving the forceps in different directions, he makes sure that he has the growth within their grasp. "Above all things, he is not to pull forcibly, but to press firmly the blades together, biting or chewing a little, if I may use the terms, with the extremities of the blades without changing the original situation of the bite or grasp. Then a little twisting movement may help to disengage the mass, which, if accomplished, the forceps will be felt free, and may be withdrawn with their contents, after which the finger enters to feel what remains and what more must be done in order to complete the removal. Let me remark, whenever the forceps has removed a portion, however small, the instrument should never be re-introduced until the finger has again examined the interior." It is best to leave the detached pieces in the bladder and to remove them together at the end with a scoop.

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* It is noteworthy that all the surgeons of widest experience have declared for the supra-pubic method—viz., Sir H. Thompson, Guyon, Volkmann, Dittel, von Antal, &c.

† A ragged ulcerated surface, large sessile tumours, and multiple soft masses, are the most unfavourable to deal with. Beyond a palliative cystotomy the first admits of no interference.

If the tumour has not been separated by the moderate use of the forceps just described, it will probably be found, on introducing the finger, so nearly severed that the actual division may be completed with the finger-nail or by one of Sir H. Thompson's serrated instruments for this purpose.

The same surgeon thus draws attention to the great risk of making strong supra-pubic pressure while forceps are being used:—"If that pressure is considerable, it forces the upper wall of the bladder into its own cavity, and thus gives the growths a larger contour than they possess, and makes them apparently salient to a much greater extent than they really are. Thus, an eager or inexperienced operator, unaware of the effects of strong supra-pubic pressure, might be led to seize the mass offered to the forceps through the influence of this pressure, and, under the belief that it was a large growth, he might inflict a fatal wound by crushing a double fold of the coats of the bladder, and so make an opening in the peritonæum. To avoid such a catastrophe, it is only necessary, first, to decline the attempt to destroy any growth which is clearly not sufficiently salient to admit of complete or nearly complete removal; and, secondly, never to employ the forceps while forcible supra-pubic pressure is made—at least, no more pressure than is desirable just to steady and support the bladder and the parts adjacent."

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* *Brit. Med. Journ.*, 1884, vol. i. p. 1240; *Tumours of the Bladder*, p. 80.

The sharp spoon or a curette is often useful in scraping down the base of a growth, after the chief mass has been removed by the nail, or nibbled away with forceps.

When a growth has a sufficiently long pedicle, it may be dragged out into the wound and cut away or twisted, or divided with the écraseur in the way adopted by Mr. Davies-Colley and Mr. Pitts (*Clin. Soc. Trans.*, vols. xiv. p. 104; xviii. p. 320; xx. p. 69).

But usually the surgeon determines to make a supra-pubic opening at once, owing to the growth being large, multiple, beyond reach, &c., and first places a bag in the rectum* and distends it with 8 or 10 oz. of water (p. 916). The bladder is then injected with 8 or 10 oz. of Thompson's fluid (p. 918), either through the penis or through the perinæal wound, by a large catheter, this wound being finally plugged around the catheter with sponges dusted with iodoform, aided, if needful, by the finger of an assistant. The supra-pubic opening is then made as at p. 920, with this exception, that, when the bladder is distinctly reached, one or two sutures of carbolized silk are passed across the site of the intended opening into the bladder with a curved needle in a handle. The opening into the bladder is then made (carefully, so as not to divide the underlying silk), the silk is hooked up and divided; by this means two or four sutures are present—one or two on either side—which will serve to raise up the bladder as required, and to keep it well open and within reach during the manipulations needful for the removal of the tumour. I prefer the use of two Spencer Wells' or tenaculum-forceps on either lip of the wound, held by assistants; the threads when pulled upon are liable to make considerable openings in the delicate tissue of the bladder. The growth may be removed by the finger-nails, one working from the upper and another from the perinæal opening, or by one of the instruments already mentioned. Hæmorrhage may be arrested by the injection of hot water, or solution of ferr. perch. (1 to 4). Any later bleeding and cystitis will probably be benefited by injections of silver nitrate (gr. 1 to 4—℥ij). This should be left in the bladder for a few minutes, and neutralised, if needful, by a saturated solution of common salt.

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* If the bladder be fixed by the growth the bag will help but little. It should, I think, be always tried, where prolonged manipulations are expected, owing to its steadying effect upon the bladder.

The galvanic écraseur should never be used unless other instruments have failed. The loop will, no doubt, shear away, without hæmorrhage, large masses which, from their size, poorly marked pedicles, and vascularity, are very difficult to deal with otherwise. But its liability to introduce septic complications, and the difficulty of manipulation in a deep contracted space, are grave objections to the cautery.* If the surgeon is driven to use an écraseur, he should employ the ordinary wire one, on account of the above-mentioned septic complications. With regard to the size of the tumour, it is remarkable, if the anæsthetic is taken well, how much may be removed by a process of quiet nibbling combined with careful torsion. Mr. Bryant (*Lancet*, 1886, vol. ii. p. 1076) found the following method useful in the case of a bladder which appeared to be filled with villous growth:—A great deal having been removed by forceps, the bladder was scraped throughout, the walls being wiped rather roughly with a new sponge tightly tied round a forceps. Hæmorrhage recurred six months later, persisting for a week; it then stopped, and the man was doing well eighteen months after the operation. Whatever method is used, the surface left should be as smooth as possible, to diminish the risk of phosphatic deposit.

When the operation is completed the cut edges of the bladder should be stitched with fine catgut to the edges of the wound in the manner I have advised at p. 921. The reasons there given against closing the bladder wound with sutures are here stronger still. Where owing to prolonged disturbance of the parts it will be needful to provide good drainage, or to wash out the bladder completely, the urethra should be opened in the perinæum, and a large Jacques catheter passed between the two wounds.

In women, bladder growths may be attacked either by dilatation of the urethra or by supra-pubic cystotomy. In this latter case the fluid with which the bladder has been injected must be retained during the first part of the operation by the pressure of an assistant's finger over the urethra. Dilatation of the urethra, which will always be practised for exploration, will suffice in simpler cases. It should always be rapid; if the three-bladed dilator is not forthcoming, a Bryant's urethra-speculum, or consecutive œsophageal bougies, will be useful.

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* In one case brought before the Clinical Society (*Lancet*, December 3, 1887) Mr. Parker used this method successfully, examining the base of the growth and every part of the bladder with a small incandescent electric lamp introduced for the purpose. See also the case, p. 902.

Resection of part of the Bladder for Growths.—A few cases have been recorded with a sufficient amount of success to justify a repetition of the operation in a few selected cases. The growth must be situated on the upper aspects of the bladder. An attempt may be made to operate extra-peritonæally by raising the peritonæum. But when so grave a step as partial resection of the bladder is contemplated, the surgeon should not allow himself to be hampered by want of room. It will probably be better to extend the parietal incision upwards, pack away the intestines with flat sponges, and endeavour to keep the urine soaked up in the same way. The growths should then be carefully resected with the adjacent bladder-walls, the chief bleeding points temporarily closed by compression-forceps, and the cut edges then united by Lembert's sutures (p. 788). Mr. Pitts (*Clin. Soc. Trans.*, vol. xx. p. 71) suggested that removal of the bladder for malignant growths might be rendered safer by previous diversion of the ureters. An interesting paper on this subject, based on experiments on the cadaver by Messrs. Edmunds and Ballance, will be found in the *St. Thomas's Hospital Reports*, vol. xvi. p. 101.

Four cases of Bardenheuer's of total extirpation of the vesical mucous membrane are recorded in the *Wien. Med. Presse*, 1889, Hft. 27, 28. In the first case, a man, aged fifty-seven, a growth occupied the whole of the fundus. The upper part of the bladder was removed, and all the vesical mucous membrane. For ten days the wound looked well, on the fourteenth death took place from anæmia. In the second, a girl, aged seven, the mucous membrane was removed for primary vesical tuberculosis. Healing was complete, death took place a year and a half afterwards from return in the peritonæum. The third and fourth patients, in each of whom the entire mucous membrane was removed, recovered, one with a fistula.

Difficulties during Removal of Bladder Tumours.

1. A very contracted bladder. 2. Growths very large, or multiple and diffuse, or without peduncles. Their situation may be far back in the fundus, or their structure show long delicate filaments, which, floating in fluid, are difficult to detect and catch. 3. Hæmorrhage. This may be very troublesome, and obscure the field of operation. It usually yields, either spontaneously, after the removal of the growth, or to sponge-pressure,

injections of hot* boracic acid, or dilute solution of iron perchloride (1 to 4). 4. Infiltration of the bladder-wall by growth.

Causes of Death after Removal of Bladder Tumours.

1. Shock. Mr. R. Harrison (*Lancet*, 1884, vol. ii. p. 678) records a case of a man, aged forty-two, who died somewhat suddenly, apparently from shock, twelve hours after removal of a villous tumour by the perinæal method. The hæmorrhage, which had begun four years before, had for a year been persistent and considerable.† 2. Exhaustion. 3. Cellulitis. 4. Failure of the kidneys. Evidence of this will of course be sought for before. It is most likely to occur in growths which from their position have obstructed the outflow of urine. 5. Injury to the bladder and peritonitis. Mr. Bryant (*Lancet*, 1886, vol. ii. p. 1077), mentioned a case in which a fibrous polypus was drawn from the fundus into the perinæal wound and snipped off. The man died of peritonitis, and a small hole was found in the bladder at the site of the removed polypus. 6. Recurrence. This may appear first in the cicatrix of the wound. 7. Abscess in the track of the apparently healed wound, bursting into the peritonæal cavity (Sir H. Thompson, *Clin. Soc. Trans.*, vol. xxi. p. 46).

OPERATIVE INTERFERENCE IN TUBERCULAR DISEASE OF THE BLADDER.—This may be (*a*) palliative, as where the male urethra is opened in the perinæum, and an attempt is made to scrape any ulcer that is detected, or to apply strong solutions of silver nitrate (ʒj or ʒij – ℥j) or iodoform emulsions to the surface of the bladder. The same operation may be performed in the latest stages of the disease to give relief to the incessant agonising tenesmus. But here the presence of the tube, which is needful to prevent the wound from closing, is of itself, too often, a source of much misery. Another operation is dilatation of the female urethra for the application of silver nitrate, &c. I can testify to the great relief given by this to the hæmaturia, tenesmus, frequent micturition, &c., but it is only shortlived, not lasting over two or three months. (β) It will be far wiser in these cases, judiciously selected, to resort to early supra-pubic exploration and the use of the sharp spoon and iodoform. These ulcerations are so likely to be diffuse and multiple, and the perinæal opening or dilatation of the female urethra gives so little room for the use of instruments, that it will be better to resort to an operation which admits of thorough exploration instead of working in the dark. But, as I have said, there must be a judicious selection of cases. The diagnosis will generally be easy if the age, family and personal history (*e.g.*, previous disease of bone, joint or glands, tendency to winter cough, &c.), the relative amount of blood and pus, perhaps the presence of the tubercle bacillus, and the absence of any evidence of stone and growth, are duly weighed. But this will not be enough. Evidence of similar mischief in the kidneys, vesiculæ seminales and prostate, and of any advancing disease in the lung, must be excluded, and a due trial (in early cases) made of milder methods, including, where this is possible, a sea voyage; where these fail or cannot be tried, and where other points are favourable, supra-pubic cystotomy should be resorted to without delay, for the course of tubercular cystitis is one steadily down hill (occasionally arrested by one or two periods of apparent tranquillity and latency of the mischief), and is ended by extremely painful deaths.

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* Mr. Southam, *Brit. Med. Journ.*, 1886, vol. ii. p. 716, arrested very severe hæmorrhage by injecting water of about 120° with a Higgenson's syringe.

† Mr. Harrison, in illustration of the sudden and excessive bleeding to which villous tumours are liable, even when they appear comparatively quiescent, has published (*Liverpool Med. Chir. Journ.*, July 1884) a case where death took place from this cause in nine hours. In this instance slight hæmaturia had existed for some months previously, but no operation had been performed.

Operation.—This is so fully described at p. 920, that it need not be further referred to now. When the bladder is opened and its cavity thoroughly exposed and emptied, a small sharp spoon should be thoroughly applied to the ulcers, any undermined edges of mucous membrane snipped away, and then iodoform well rubbed in. The disease here should be treated as thoroughly as in the case of tubercular disease of skin or glands or joints, only more carefully. Bleeding may be arrested by the means given at p. 900. Mr. Battle, in a case which he brought before the Clinical Society (*Brit. Med. Journ.*, vol. i. 1890, p. 1011), successfully treated in this way after other methods had failed, used a solution of zinc chloride (gr. 30 – ℥j). I would point out the great help given by the electric lamp in these cases. In May 1890 I was asked by Dr. Cock and Dr. Hodgson, of Exmouth, to explore the bladder of a gentleman, aged fifty-seven, suffering from painful cystitis, hæmaturia, frequent micturition, in whom general treatment, washing out the bladder and drainage by a catheter, had failed to give any relief. Calculus being excluded by sounding, and there being no rectal enlargement of the prostate, I expected to find a small malignant growth, as the symptoms were too urgent for enlarged prostate, and this gland was not enlarged either to the finger or the sound. The bladder, being opened and emptied by the supra-pubic method, at first appeared normal save for some sub-acutely inflamed rugæ which stood out very distinctly on the right lateral aspect of the neck of the bladder. A small electric lamp at once showed amongst these folds two ulcers each about 1 inch by ¼ inch, oval in shape, with muscular fibre clearly exposed on their floors, their edges neither thickened nor indurated. They were scraped with a sharp spoon, and then iodoform rubbed into their surfaces. The patient made an excellent recovery, and now, nine months later, remains quite well. I am quite unable to clear up the nature of this case, unless the ulcers were an anomalous form of the tubercular. The case must of course be watched for a long period before it can be claimed as a cure. But it shows what relief the supra-pubic method will give. In this patient, with a deep fat perinæum, I should never have detected these ulcers.

PROSTATECTOMY.

We owe our knowledge of what this operation can do to Mr. McGill, of Leeds, whose untimely death has cut short so much other good work as well. Many of my readers will have been struck by the series of cases which Mr. McGill showed at the Leeds meeting in August 1889. The following propositions are taken from Mr. McGill's paper:—i. Prostate enlargements which give rise to symptoms are intra-vesical, not rectal. Thus prostates of immense size which project towards the rectum cause no urinary trouble, while severe symptoms may supervene when the prostate on rectal examination is apparently of normal dimensions. ii. There are many varieties of the intra-vesical growth. We find (1) a projecting middle lobe—pedunculated or sessile, (2) a middle lobe with lateral lobes forming three distinct projections, (3) the lateral lobes alone, (4) a pedunculated growth springing from a lateral lobe, and (5) "a uniform circular projection surrounding the internal orifice of the urethra." This variety, described by Brodie, is not unfrequent, it surrounds the urethra like a collar, and projects for a variable distance into the bladder. iii. In many cases self-catheterism is the only treatment required. iv. That when this fails, or is unavailable, more radical measures are necessary. v. That this treatment, to be effectual, should (1) for a time thoroughly drain the bladder; (2) permanently remove the cause of the obstruction. I have only one criticism to make here, and I mention it with all due deference to one who was so sound a surgeon, and who is now beyond reply. Mr. McGill speaks of the perinæal method as the only means of giving efficient drainage. Now it has been proved by Sir H. Thompson (*Dis. of the Prostate*, p. 172) and by Mr. T. Smith (*St. Barth. Hosp. Reps.*, vol. vii. p. 291) that where in cases of enlarged prostate causing very severe symptoms, the patient's strength is running down owing to the frequent calls (perhaps hourly), night and day, to pass his catheter, permanent relief may be given by supra-pubic puncture, and Sir H. Thompson has devised special instruments by which this may be done without injuring the peritonæum when the bladder is empty. Mr. T. Smith has published (*vide supra*) several cases in which the patients were able to go about in comfort with a small supra-pubic tube and shield, by which they emptied their bladder regularly. It must never be forgotten that the subjects of advanced prostatic disease are not good lives, and must usually be bad subjects for operation, owing to the state of their prostates, the difficulty (even now-a-days) of keeping a wound here quite aseptic, and the condition of their kidneys and their lungs. I am of opinion that prostatectomy is never justifiable unless a trial of supra-pubic drainage has been tried. Even if this fail, which it rarely will, to give permanent relief, it will put the patient in a better condition for the severer operation by the rest to the bladder and the facilities for cleansing the viscus which it affords. vi. That the supra-pubic route is preferable to the perinæal for prostatectomy. Most surgeons will agree with this; the question has been already treated at p. 896. Mr. McGill described the operation very briefly.* The following are a few special points as to technique. The quantity of water (p. 916) injected into the rectal bag, especially when the prostate is abnormally hard, should not exceed 6 to 10 oz. Where the bladder is contracted with thick non-distensible walls, it will usually be inadvisable to perform this operation. A catheter left in the bladder till it is opened expedites the operation. Mr. McGill advises that the bladder be stitched to the cut edges of the wound (p. 921) before any attempt is made to remove the prostate. This should be effected as far as possible by enucleation with the finger, not by cutting. The mucous membrane over the projecting portion having been snipped through, the growth is removed by finger and forceps. Hæmorrhage is best arrested by irrigation with water so hot as to make it unpleasant to the hand. A large drainage-tube should be inserted and retained for forty-eight hours. The upper part of the wound should be sutured above the tube. Of Mr. McGill's seventeen cases, four only died, three of these directly from the operation, two were still under treatment, and one could not be traced. Of the remaining ten, eight continued well. One had temporary relief, relapsed after ten months, and died insane. In the remaining case the operation could not be satisfactorily completed, owing to the extreme hardness of the prostate, and the supra-pubic drainage which was adopted gave but slight relief.

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* In a paper read before the Clinical Society (*Trans.*, vol. xxi. p. 52) Mr. McGill in one case seized the growth with large clamp-forceps, and partly by tearing, partly by scissors, removed all the projecting portion in small pieces. In other cases, scissors, vulsellum-forceps, and Sir H. Thompson's bladder-forceps were employed.

Mr. Buckston Browne (*Clin. Soc. Trans.*, vol. xxii. p. 274) has recorded a case of much interest on account of the large amount of prostatic growth removed, and the excellent recovery made. The patient was eighty-seven, and suffering most acutely from vesical irritation and spasm. Supra-pubic cystotomy revealed "an enormous prostatic outgrowth from the right side of the vesical urethral orifice; the base was broad, the tumour itself smooth and firm, and it apparently filled the bladder. For a moment I hesitated whether to remove the growth, or to be content with simple drainage, but it was evident that no relief could be obtained as long as the bladder contained what was practically a large foreign body, and the removal of the growth was therefore proceeded with. This was accomplished piecemeal by means of finger and forceps, the only difficulty being in getting the first piece away, for directly the prostatic envelope was broken into, the remaining portions were easily seized and twisted off; they were lobulated and not unlike pieces of pancreas, only harder. Every portion when seized was removed by torsion; nothing was pulled or torn away, and in consequence there was very little bleeding. The whole of the gland removed weighed nearly 4 oz. When all the growth was cleared away the urethral orifice was level with the adjoining vesical surface, and its upper and left portions intact." A good recovery followed.

LATERAL LITHOTOMY (Figs. 143, 144, 145).

The lateral operation will be described under the following heads:—

A. **Preparatory Treatment.**
B. **Passing the Staff. Possible Difficulties.**
C. **Finding the Stone. Possible Difficulties.**
D. **Entering the Bladder. Possible Difficulties.**
E. **Extracting the Stone. Possible Difficulties.**

A. **Preparatory Treatment.**—For a week or so before the operation the diet should be bland, so as to tax as little as possible jaded kidneys—*e.g.*, milk, barley-water, light puddings, and a little fish. If alcohol is needed, some sound spirit, well diluted, should be given. Baths should be taken regularly, the bowels well moved, and an enema given on the morning of the operation, and care should be taken that all this has come away.

B. **Passing the Staff.**—This step, however simple and easy usually, presents occasional difficulties, the more trying, because perhaps unlooked for; they are—

(1) Spasm, from the urethra not being used to instruments. (2) Stricture. (3) False passage. (4) Enlarged prostate. (5) An enlarged prostatic sinus, into which the end of the sound passes. Mr. Buckston Browne's staff meets the last two admirably.

C. **Finding the Stone with Sound or Staff. Possible Difficulties.**

(1) The stone may have been passed.* This is not impossible in children with small, smooth, narrow calculi, and their sudden, strenuous micturition. (2) The stone may lie behind an enlarged prostate. Here the finger of an assistant passed into the rectum may help. (3) The stone may be enveloped in folds of mucous membrane. Injection of the bladder is here indicated. (4) The stone may be encysted. This is so rare as to have been called "the refuge of young lithotomists." The following case of Prof. Humphry (*Some Cases of Operation*, Pamphlet, 1856) shows well how embarrassing this condition may be:—

A man, aged fifty-one, was cut, then submitted twice to lithotrity, then again cut in the old scar three times, all within six years, for an encysted calculus. On the fourth occasion of lateral lithotomy the nature of the case was made out accurately. The stone was now felt behind the prostate, attached to the bladder by a pedicle which seemed to penetrate the coats of the viscus, and to be attached to another mass beyond it. It was evidently a stone of hour-glass shape, part being in the bladder and part in the sac. At each of the previous operations the part within the bladder had broken off, the rest not being extracted, owing to the size of the prostate. The symptoms recurring, urethro-rectal lithotomy was performed. The stone being now within reach, the edge of the mucous membrane around it was incised with a hernia knife, and a stone, the size of a walnut, and with a truncated stalk, extracted. Death took place in two days, from pelvic cellulitis. Though the bladder was otherwise but little diseased, the cyst seemed to have originated from the protrusion of mucous membrane between the muscular fibres, as another one existed, though without a stone. The cyst communicated by a considerable opening with the foul, infiltrated tissues. Prof. Humphry asks whether this was due to his manipulations of a delicate sac, and whether supra-pubic lithotomy would not have been better. In another case, Prof. Humphry was able to remove a similar calculus successfully, by lateral lithotomy, after repeated introduction of forceps and scoop. He points out that these cysts may be quite out of reach in lateral lithotomy. As their walls consist only of cellular tissue, mucous membrane, and perhaps a thin layer of muscular fibre, they are easily lacerated during an operation, an accident almost certain to be fatal. The diagnosis is usually to be made if the stone is always struck by the sound at one spot, especially if, per rectum, a lump is detected corresponding to that spot.*

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* *Cf.* the case mentioned by Mr. Holmes, *Clin. Soc. Trans.*, vol. ii. p. 67.

D. **Entering the Bladder.**—The time chosen for introducing the staff varies with different operators. Passing the staff while the patient is still recumbent is the easier; passing it when the patient is in lithotomy position is rather more difficult, but secures the operator against the risk of the staff slipping out after the patient is brought down into position, a risk which is greater with the straight staff. I prefer to bring the patient's lower limbs over the edge of the table, to pass the straight staff while he is thus recumbent, and then to have his limbs only brought up into position.

The nates just projecting over the edge of the table, the sacrum being flat upon it, the flexed thighs and legs being held well out of the way, the surgeon, seated comfortably, and with his face on a level with the perinæum, directs an assistant so to hold the staff as to bring the membranous urethra close to the surface of the perinæum. If a curved staff be used, this is easily done by inclining the handle strongly towards the abdomen. By this manœuvre, in Mr. Cadge's words (*loc. supra cit.*), the point of the staff "need not, and should not, be withdrawn from the bladder, but if it were it would be of no moment, because it would re-enter it the moment the handle is raised; the membranous urethra, instead of being almost perpendicular to the surface of the perinæum, as it is when the staff is held upright, is brought almost parallel with it, and is much easier to find with the knife; there is no inducement to open the urethra too far forwards, and consequently no risk of wounding the bulb or its artery. The staff gets a steady rest against the front of the pubes, and there is no danger to the rectum at this stage."*

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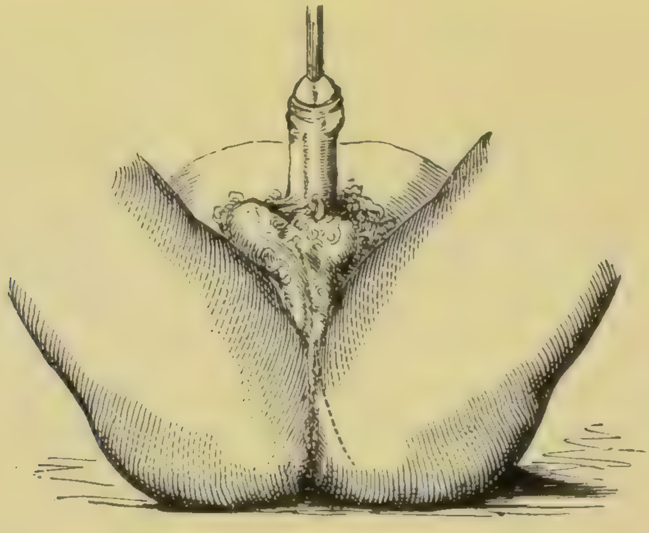
* Erichsen (*Surgery*, vol. ii. p. 945) adds that the beak cannot be made to pass round such a stone, so as to isolate it.

Having felt the staff thus presented towards him, having examined into the depth of the ischio-rectal fossa, the site of the tuber and ramus ischii, the surgeon pressing up the junction of the scrotum and raphé so as to make tense the parts just about to be cut, enters his knife from ¾ inch to 1½ inch from the anus, just to the left of the raphé, and very likely hits the groove at once. The knife is then drawn outwards and backwards with a rapid sawing movement, to a point midway between the anus and tuber ischii, thus making an incision of 2 to 3 inches, according to the age of the patient and size of the stone. Again inserting the knife into the upper angle of the wound, the surgeon makes out exactly with his left index finger the groove in the staff, and exposes this, beyond doubt, in the wound. The next steps differ somewhat, accordingly as the curved or straight staff is used—they will be given separately.

FIG. 143.



(Fergusson.)

(*a*) **With the Curved Staff.**—When the knife-point is felt firmly lodged in the groove, its handle is a little depressed, the blade, at the same time, turned a little to the left, is pushed steadily along the groove till a gush of urine or a sense of resistance ceasing, or both together usually, announce that the neck of the bladder has been sufficiently divided with the knife. The finger is now wormed into the bladder over the concavity of the staff.

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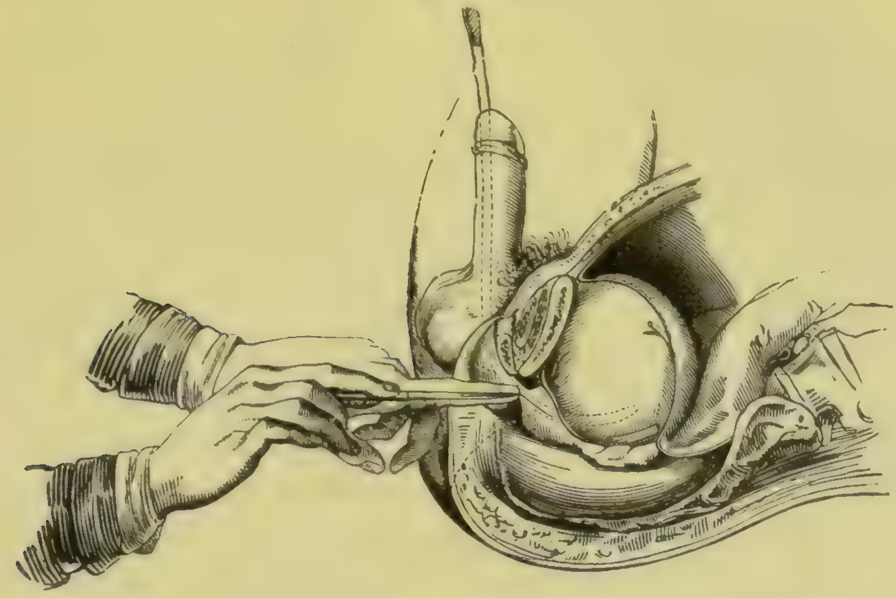
* It thus combines the advantages of the two very different methods usually given—viz., either to hold the staff well up firmly under the pubes and thus away from the bowel, but also away from the stone; or closely down upon the latter and in proximity to the rectum also.

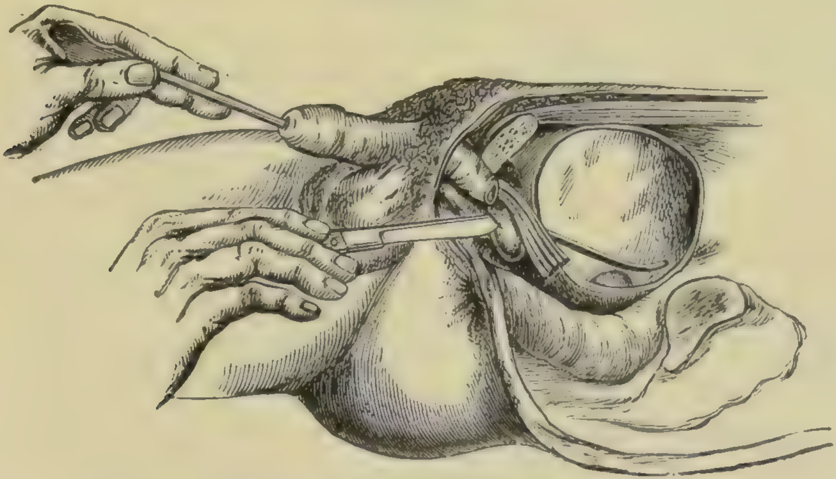
FIG. 144.



(Fergusson.)

(*b*) **With the Straight Staff.**—When the point of the knife is felt to be safely lodged in the groove, the surgeon takes the handle of the straight staff from his assistant, brings it down, and still keeping his knife in the groove, lateralizes the staff slightly to the left, the handle of the knife being now depressed so as to form a sufficient angle with it, and make an adequate wound, the

FIG. 145.



Lateral lithotomy with a straight staff. (Key.)

surgeon runs it along the groove steadily, till he knows by the above given evidence that the neck of the bladder has been sufficiently cut.

The left index finger is next wormed over the edge of the staff, the straight staff being held by the surgeon himself, in his right hand, the curved one being held by an assistant, till he feels that he has entered the bladder and placed the finger tip, if possible, in contact with the stone. Entrance into the bladder is known by feeling the finger surrounded with a smooth cavity, lined with mucous membrane, while the finger itself is girt by a fibrous ring. The stone being felt, or the bladder cavity distinctly gained, the staff is withdrawn, and the surgeon, while taking his lithotomy forceps, dilates the opening into the bladder with his finger, which, at the same time, pulls down and steadies the neck.

Failure to Enter the Bladder.—This most vexatious and embarrassing difficulty is most likely to be met with under two widely different conditions—(1) most frequently, in little children; (2) in old patients with a very fat, deep perinæum, and enlarged prostate. The first must be considered separately.

(1) *In Little Children.*—The causes here are, the small size, delicacy, and mobility of the neck of the bladder and urethra, and the fact that the bladder lies high up above the pelvis. Mr. Cadge quotes the following from Sir W. Fergusson: "The point of the finger was, as usual, placed on the staff and pushed gently towards the bladder. The finger went on, but I was aware that it had not got between the urethra and the staff. With an insinuating movement (much to be appreciated by the lithotomist who, as I do, professedly makes a small incision in this locality), I endeavoured to get its point, as usual, into the urethra and neck of the bladder. But here I felt convinced that I had failed, and was aware that the finger was getting deeper as regards the depth of the perinæum, but that I was not materially nearer the bladder. I could feel a considerable space at the point of the finger, and was convinced that the upper part of the membranous urethra, as well as the sides, had given way to the pressure, and that now, as the finger was getting deeper into the wound, I was only pushing the prostate and neck of the bladder inwards and upwards. These parts seemed to recede before the smallest imaginable force, whilst I felt that I could, in a manner, make any amount of space around the bare part of the staff. I had no difficulty in distinguishing between the surface of this space and that of the mucous membrane of the bladder. Moreover, I knew that I had never crossed that narrow neck which is always felt as

the finger passes into the bladder when a limited incision is made. An impression came over me that I was about to fail in getting into the bladder, and I had an idea that, unless I could open the urethra in front of the prostate more freely, I should probably never reach the stone. This I effected with great caution, and then I could appreciate the passage of the finger as usual through the neck of the bladder. The stone was easily touched and removed, but I was forcibly impressed with the idea that I had nearly failed in the performance of the operation." The child here was four years old.

Mr. Cadge thus met the same difficulty in an infant of one year and a half: "I felt the impossibility, even with a fair incision, of distending the wound with my finger; it was like trying to get it into the orifice of the urethra. I therefore desisted before doing any harm, and, taking a pair of common dressing-forceps, I passed them easily along the staff into the bladder; by opening the blades gently but firmly, room was gained, and the finger entered and made room for small lithotomy-forceps. But I have repeatedly, after passing the dressing-forceps, withdrawn the staff and removed the stone with them, and without introducing the finger at all."

Difficulties and Mistakes during this Stage of entering the Bladder.—This is so important a part of the operation that the following may be enumerated here:—

1. Finding the staff. This is not likely to present difficulties in the case of a curved staff if it be held as advised at p. 907. Hitting a straight staff in a fat child is not always easy, owing to the small size which is needful. Attention must be paid to entering the knife at the root of the scrotum only just to the left of the raphé, when the finger-nail will detect the staff at once.

2. Not exposing the staff. Everything which lies over the staff in the upper angle of the wound must be clean cut. The tissues here, including the membranous urethra, are lax and delicate, and, unless the knife is clearly in contact with metal, the groove will not be followed.

3. Losing the groove. This most serious accident may be due to not getting the knife cleanly into the groove, not keeping it sufficiently firmly in contact with it, and, thirdly, by forgetting to depress slightly the handle of the knife.

4. Cutting the prostate too freely as the knife is brought out. This can easily be avoided by keeping the knife sufficiently near to the staff.

5. Cutting into the rectum. This may be due to neglect of

the following precautions:—(1) Keeping the staff up away from the bowel; (2) guarding the bowel with the left forefinger in the wound; (3) when the knife is lateralized, cutting away from the gut.

Mr. Cadge (*loc. supra cit.*) points out that the usual place of puncture is the dilated part just above the internal sphincter, and that this communication may be made secondarily by sloughing after extraction of a large stone, or after the use of a plug for arresting hæmorrhage. His experience is that "Nature seldom fails to bring about a cure, or so to contract the wound as to leave but trifling inconvenience."

6. Wounding the posterior wall of bladder. Sir S. Wells, at the discussion on Sir H. Thompson's paper (*Med.-Chir. Soc.*, April 2, 1878), mentioned a case in which Mr. Tyrrell wounded the back of the bladder, and hence always advocated a short knife.

E. **Finding and Extracting the Stone.**—The surgeon's left index finger, having passed into the bladder along the convexity of the staff,* finds the stone, hooks this down as near to the neck as possible, and at the same time steadies the neck while it dilates the incision in it and in the prostate. This combination of movements requires most careful attention to each of its details separately. The most important of these is the dilatation of the neck and prostate. If the stone is found to be a large one, the deep part of the wound must be sufficiently free. It is well known how much has been written on this matter. The surgeon should begin by dilating the neck of the bladder carefully and equally in every direction, using a considerable amount of force in an adult, but not throwing this on any limited portion of the wound. It may be accepted as a certain fact that the wound in the prostate may extend through the whole of this body, without risk of cellulitis, if only the recto-vesical capsule is not torn through. As long as the finger is girt by a fibrous ring this mischief has not been done. Whether an extensive wound in the prostate had better be made by dilatation and laceration or by free incision will probably never be settled. The wise surgeon will avail himself of a safe use of both—that is to say, after dilating with forcible but equal pressure all around the original wound in the neck, he will introduce a blunt-pointed narrow-bladed bistoury flat against the pulp of his finger, and nick the remaining constriction at one or two places, cutting rather than nicking towards the right side.

Next to the size of the stone the age of the patient must here be considered. After middle life, the cellular tissue around the neck of the bladder is not only loose, but abounds in enlarged veins. Hence the risk of causing not only cellulitis, but septic phlebitis, by dilating an inadequate opening by the tearing, bruising exit of the stone, instead of by the finger and knife combined.

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* This is only withdrawn when the stone is felt, not before.

The deep opening being thus made sufficiently free, the surgeon, having selected his forceps, introduces them along the finger (thus further dilating the wound), the latter being withdrawn as the forceps enter. These held at first in one hand (the thumb in the ring) are fully introduced closed, then opened widely transversely, and, by a quarter turn of the handles, the lower blade is made to scoop or sweep along the floor of the bladder, which will almost surely catch the stone. If this step fail, it is repeated, and if the stone is still not caught, the surgeon feels again for the stone either with the closed forceps or by again inserting his finger, which will bring down the stone, push off projecting folds of mucous membrane, &c. Differently curved forceps, supra-pubic pressure, and a finger in the rectum, may all help now.

The stone being caught, the finger again feels if it is held in its shorter axis; if so, it may at once be extracted, if moderate in size, by steady deliberate traction downwards and outwards. As long as the stone advances, all is well; if not, gentle rotation may again start it on its way. In less easy cases Mr. Cadge's words should be remembered: "Should there be much resistance and no sense of gradual yielding, the surgeon will ask himself whether this is due to an insufficient opening, or to the projection of the ends of an oval stone laterally beyond the bladder. This latter may be known by observing that the bladder is brought bodily down, so that the prostate, which is probably large, is visible near the external wound; in this case the stone must be liberated, the finger again introduced, and a fresh hold taken. If the obstruction is due to a large stone and too small a wound, the latter is to be enlarged in the direction of the first incision; this, in the opinion of the writer, is preferable to making the division of the neck of the bladder on the opposite side, and preferable, too, to using undue traction and force."

In some cases a scoop will facilitate extraction, the stone being firmly held between the pulp of the left index finger and the concavity of the scoop. In children one finger in the rectum and one in the bladder will often serve the purpose.

The stone being out, the bladder is carefully explored with the finger, or a short-beaked staff, aided by pressure above the pubes, or from within the bowel, for any other calculi or fragments.

Multiple calculi will have been indicated by facets upon the first.

Any bleeding vessels are now secured, and the patient, wrapped up in blankets, is removed to bed.

Difficulties during the Stage of Extraction of the Stone.

(1) The position of the stone. This may be out of reach owing to its being at the posterior part of a dilated bladder, above the pubes, or to the patient having a very fat and deep perinæum. Pressure above the pubes, and the use of long forceps, are here indicated.

(2) An enlarged prostate. This interferes with reaching the stone both with finger and forceps. Curved forceps passed in along the staff, or a gorget, if the perinæum be very deep, will be helpful here, and perhaps a bag in the rectum would aid in raising up the stone within reach in difficult cases. An enlarged middle lobe of the prostate, or a separate adenoma of this gland, may also cause trouble by getting between the blades of the forceps. Tearing away of these portions of the gland has often occurred, and is sometimes certainly beneficial.*

(3) Breaking up of the stone. This may occur with hard calculi from too much force being used with the forceps, but it much more often happens with soft phosphatic calculi. In such cases every fragment must be cleared out, a matter of some difficulty, as small ones are readily concealed in clots or folds of mucous membrane. After all the larger ones are picked out, a catheter of appropriate size, attached to a Higgenson's syringe, is inserted, and the bladder thoroughly and forcibly washed out with diluted Thompson's fluid (1 in 6 or 8 : p. 918). In a week or ten days the bladder should again be carefully sounded, and examined with the finger, and any fragment extracted, this being especially needful if pain has persisted after the operation.† If fragments still persist a little later, an evacuating-tube and washing-bottle, aided if necessary by a flat-bladed lithotrite, must be employed. I may

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* It is doubtful if this is always so. Thus Mr. Cadge (*loc. supra cit.*) thinks "that it is probable that a careful examination of the subsequent condition of such patients would show that, although it may not have endangered life, it has not infrequently been followed by partial inability to retain urine. Prof. Gross (*Trans. Philad. Path. Soc.*, vol. iv. p. 153) thought that in one case the cavity left behind became a suppurating pouch, and increased the difficulty in micturition.

† Recurrence of stone within two years almost always means that a fragment has been left after the operation. No greater disappointment than this, both to the surgeon and patient, can happen. No one, probably, has cut fifty patients without having to admit and lament its occurrence, but it is especially liable to occur to the inexperienced" (Cadge).

here express my belief that multiple calculi are not quite as rare as has been supposed.

(4) Size and shape of the stone. Mr. Erichsen writes on this subject: "A calculus, about 1½ inch in its shorter diameter, will be hard to extract through an incision of the ordinary length (not exceeding eight lines) in the prostate, even though this be considerably dilated by the pressure of the fingers; and I think it may be safely said that a calculus 2 inches and upwards in diameter can scarcely be removed by the ordinary lateral operation with any degree of force which it is safe to employ." Most will agree with Mr. Cadge that stones weighing upwards of 3 oz. will be dealt with by the improved supra-pubic method.

SUPRA-PUBIC LITHOTOMY (Figs. 146, 147, 148, 149).

Indications.—I may quote here from a paper which I read before the Royal Medico-Chirurgical Society (*Trans.*, vol. lxix. p. 377), and which concluded with the following propositions:—

1. "That supra-pubic lithotomy, as recently modified, has a future of renewed usefulness before it, and that while, as an operation, it can never contrast with the rapid brilliancy of the lateral operation, it will be found of great value by those who only have to deal with stone occasionally, and by those who find themselves face to face with calculi of considerable size in adults.

2. "That, to give other and more individual instances, the operation will be found useful in (*a*) many cases of hard stones of 1½ inch in diameter; (*b*) in multiple hard stones; (*c*) in cases of calculus not phosphatic, occurring with enlarged prostate; (*d*) in some cases of foreign body in the bladder with abundant calculous deposit (Sir H. Thompson); (*e*) in cases of encysted stone.*

"In the rarer cases of (*f*) a state of urethra which will not admit the use of a lithotrite or a grooved staff; (*g*) in a very deep perinæum; (*h*) in a child with deformed pelvic outlet; (*i*) in a patient with ankylosed hip-joint not admitting of his being placed in the usual lateral lithotomy position (Sir H. Thompson).

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* For an interesting case of supra-pubic lithotomy performed successfully for an encysted stone by Dr. Corke, of Baschurch, the *Lancet*, 1889, vol. ii. p. 265, should be referred to. Mr. Bond, of Leicester, records another case (*ibid.*, p. 260), in a patient aged sixty-one, who had been cut four months before, laterally, fourteen calculi being removed. At the second operation, a calculus was found embedded in the mucous membrane of the bladder, and removed successfully. But the cases which best illustrate the extraordinary difficulties which sacculated stones may offer, and how they may be successfully met by supra-pubic lithotomy, are two which Mr. Buckston Browne brought before the Clinical Society (*Brit. Med. Journ.*, 1890, vol. i. p. 239). In one of these, in addition to three calculi in a deep post-prostatic pouch, two stones were found in a vesical pouch which occupied the inguinal region.

3. "That at present, till a larger number of cases of the improved operation have been collected, it will be wiser not to attempt to close the bladder with sutures.

4. "That in reviving an abandoned operation these two questions call for an answer:—

"(*a*) Do we stand in a better position towards the operation than our predecessors did?

"This question can only be answered in the affirmative, after the work done by Prof. Petersen and Sir H. Thompson.

"(*b*) On what grounds was the operation abandoned? The chief of these appear to have been, (1) The absence of any means of certainly avoiding the peritonæum; (2) the difficulty of sufficiently and painlessly distending the bladder in pre-anæsthetic days; (3) the absence of antiseptic fluids; (4) the fact that the operation was usually reserved for very large stones, and that it was often performed for such stones after lateral lithotomy had been attempted either on the same or the preceding day."

To the above remarks I would now add, speaking from a larger experience, that the wound here is slower in closing; in fact, it may not heal firmly, as long as the urine may be alkaline. Occasionally it reopens, probably, as suggested by Petersen, from the linea alba uniting before the bladder.

The greater trouble and the longer time which this operation entails, both during its performance and afterwards, will not be grudged in these days, when it is so much the rule to pay attention to the details of surgery. Only time and a larger collection of cases will show how far, with much simpler structures to cut, with these brought safely into reach, and with modern antiseptic details at hand in the after-treatment, this lithotomy is safer than the far more brilliant lateral one.

Details of the Operation.*

A. Distension of the Rectum.—The bag used for this must be (1) of sufficient strength;† and (2) of appropriate size. Thus,

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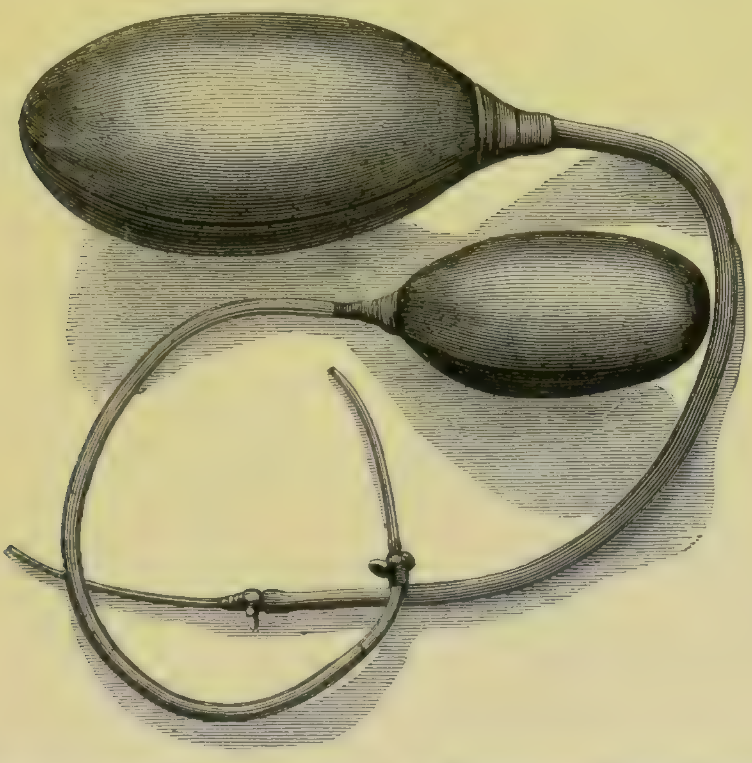
[*] These are largely taken from a paper of mine (*Brit. Med. Journ.*, October 23 and 30, 1886).

[†] M. Guyon (*Ann. de Mal. des Organ. Génito-Urin*, t. i. p. 97) mentions a case in which the bag, being of thin india-rubber, did not support the bladder with sufficient firmness; the bladder, thus yielding to pressure, was difficult to open. Any additional handling of, or difficulty in opening, the bladder must increase the risks of cellulitis.

it should be of as soft rubber as is consistent with strength, with seams as little prominent as possible,* and flattened rather than pyriform in shape. (3) The amount of fluid. A flat † oval bag (Fig. 146), well coated with eucalyptus and vaseline, entirely emptied of air and folded up, is introduced well above the sphincters (the bowels having, of course, been well emptied). It is then carefully distended by means of an easily working syringe with water varying in amount from 2½ to 3 oz. in a child of five, to 10 or 12 oz. in an adult. Sir H. Thompson gives the amount in the adult as 12 to 14 oz. I would advise operators to be content with the smaller amount of 8 or 10 oz., adding a little more later on, if needful, and only to use the larger amounts in special cases —*e.g.*, large stones, doubtful cases, or where a growth is present and it is desired to give extra elevation and steadying to the bladder.

FIG. 146.



Oval rectal bags, partly distended. A child's size is shown below.

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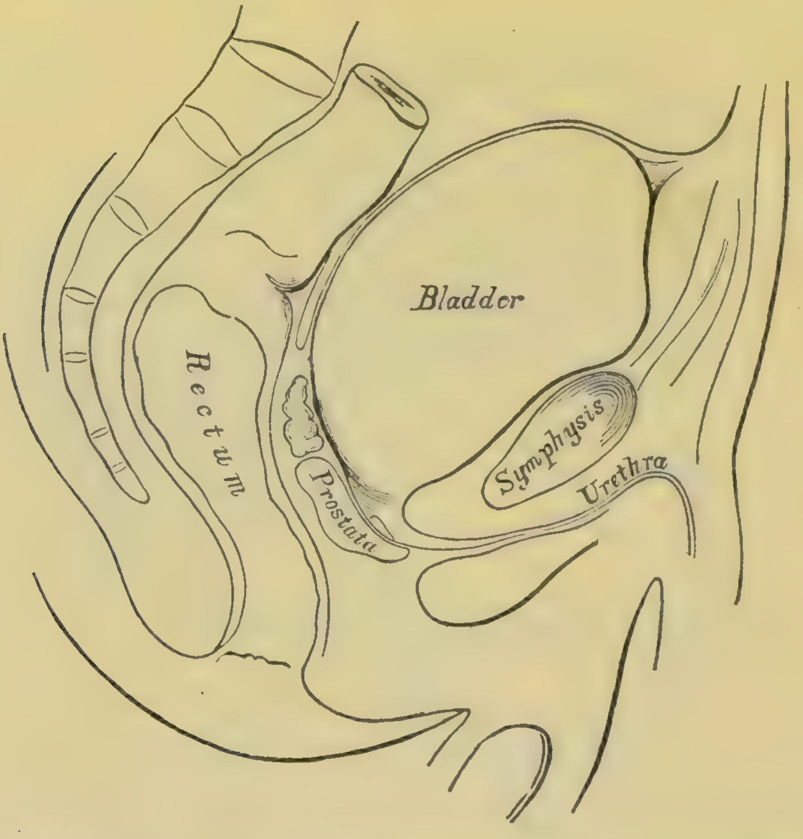
* In two of my earlier cases a little blood-stained mucus followed the withdrawal of the empty bag; no ill results ensued, and as this did not occur in four later cases, I think it may be attributed to the use of the earlier bags of pyriform shape, stout rubber, and prominent seams; when a bag has not been obtainable, a Barnes' bag, the india-rubber bulb of a spray, a ring pessary, bits of sponge attached to silk, have been used instead.

† The pyriform bags tended to raise only the centre of the base of the bladder, leaving two lateral sulci, in which it might be troublesome to find the stone.

It is evident that with such large amounts as those recommended by some—*e.g.*, M. Guyon—serious risk is run of damaging the rectal mucous membrane. That this is no idle fear is proved by a case which came to the knowledge of Mr. Cadge, in which 15 oz. in the rectal bag caused a distinct tear of mucous membrane.

B. **Distension of the Bladder.**—The urine being first drawn off, 8 or 10 oz.* of Thompson's fluid (borax, 1 pt., glycerine, 2 pts., water, 2 pts.), diluted 1 in 6, carbolic acid 1 in 80, mercury perchloride solution 1 in 1000, are gently thrown in by means of a syringe which works smoothly, and whose capacity is known. In children from two to five about 3 oz. will be sufficient. The patient should be well under the influence of the anæsthetic at this time,

FIG. 147.



Sagittal median frozen section through the pelvis of a young man, the bladder being distended. (C. Langer.)

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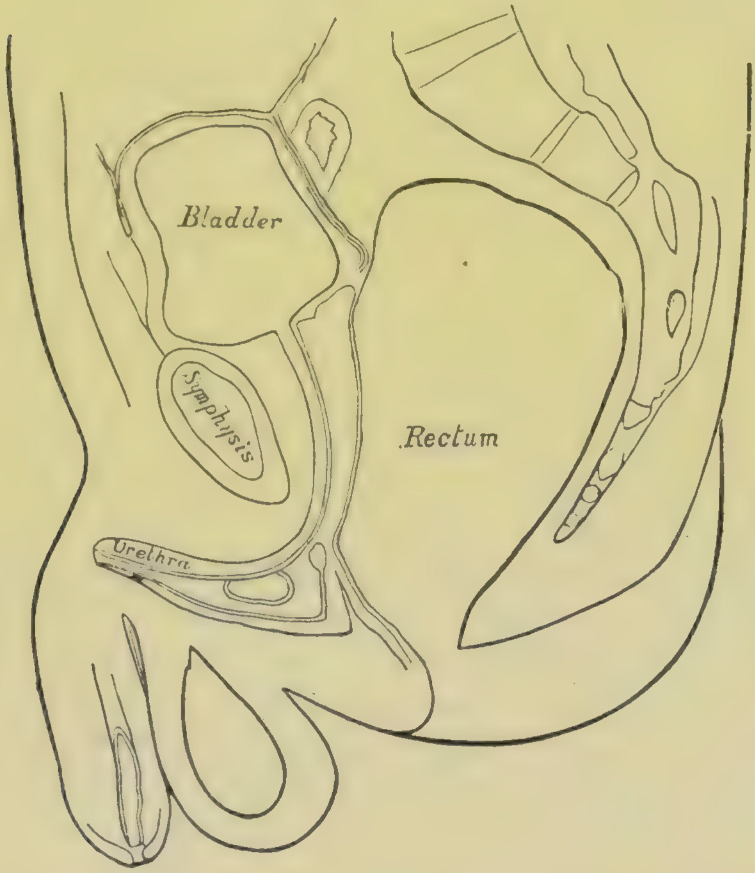
* I strongly advise my younger readers to be content, in ordinary cases, with these smaller amounts. More can easily be added later on, when the bladder has become more used to the distension. In three cases (adults) out of my ten there was so much resistance with 8 oz. of fluid, that I had to stop injecting before I could distinctly feel the bladder above the pubes, yet on dividing the superficial structures the viscus proved sufficiently filled.

and if any straining takes place the injecting must be stopped, the hypogastric region supported with two hands, and some fluid allowed to run out if needful.

It may not be out of place to remark here that the surgeon will do well, when injecting the rectum and bladder, to make sure that he is injecting fluids only. If he make trial of the bag outside the body, he will see how easy it is to send in air as well as fluids, and thus to produce more distension than is intended, unless the bag is absolutely emptied first, and unless the syringe acts perfectly. By the double distension of rectum and bladder, the latter will, if not visible to the eye, be felt by the left hand of the surgeon (which should most carefully keep touch of the supra-pubic region), reaching about two-thirds of the way to the umbilicus.

FIG. 148.



Sagittal median frozen section of male pelvis, with distension of bladder and rectum. (Garson.)

In injecting the bladder, often irritable in these cases, the surgeon must keep careful count of its resistance. M. Guyon's (*loc. supra cit.*, p. 111) words should now be remembered: "On peut complètement supprimer la sensibilité au contact, mais jamais sa sensibilité à la distension."

After withdrawing the catheter, a Jaques' catheter or a drainage tube is tied round the penis to prevent the escape of the fluid. If the surgeon desire to retain a guide to cut upon, he should distend the bladder through a silver catheter, leave it in, and plug it.

In those cases of irritable bladder, where the contents are ejected immediately a sound is introduced, attention must be paid, for a few days previous to the operation, to getting the bladder accustomed to gentle distension, steps which will also promote an antiseptic condition of the wound.

C. **The Operation Itself.**—The pubes being shaved, the knees slightly flexed, and the shoulders a little raised, an incision is made about 3 inches long, exactly in the middle line and ending over the upper border of the pubes. The subcutaneous fat, often plentiful in amount, having been divided, and any vessels secured with Spencer Wells' forceps, the linea alba is identified,* nicked, and slit up for 2 or 3 inches. The transversalis fascia is then picked up at the lower angle of the wound and divided. The retractors now drawing the edges of the wound well apart, a layer of loose tissue and of fat, often abundant, and frequently having large veins in it, will next come into view, lying over and concealing the bladder. This must be torn through carefully and as cleanly as possible with the point of the director. Any veins which cross the wound (and a transverse branch lies often just opposite the site of puncture into the bladder) should be secured with forceps. If one is opened at this stage, the field of the operation will be obscured by most troublesome hæmorrhage.† This must be arrested by pressure-forceps, which act also as retractors, by sponge-pressure, or very hot aseptic lotion—*e.g.*, hyd. per. 1 in 3000; prolonged manipulation in arresting hæmorrhage here may be the cause of that cellulitis later on which is so much to be deprecated. The anterior surface of the bladder will now be recognized by its pink colour, the fibres of the detrusor urinæ, and by its fluctuating under the finger. Veins often are met with again here on the bladder itself, longitudinal, transverse, and occasionally plexiform. Great care must be taken not to open up the fatty connective tissue which lies between the anterior surface of the bladder and the pubes. A spot on the anterior surface of the bladder having been chosen about $\frac{3}{4}$ inch* above the pubes, it is punctured (a hook being used if thought desirable), and the left index finger at once introduced to feel for the stone. The finger at the same time keeps the bladder hooked up, and prevents its settling back into the pelvis as the urine flows away. The stone is best removed by two fingers, or, if preferred, by forceps and scoop. The fingers, if successful, have the advantage of not risking any injury to the mucous membrane. Removal of the stone is not always easy; it falls back into the fundus, or into sulci on either side of the part raised by the bag. As soon as the calculus is removed and the bladder thoroughly explored, the fluid should be set running from the rectal bag, as emptying this takes some time. To prevent extravasation, the cut edges of the bladder should now be sutured with fine catgut to the fascial and deeper edges of the wound, two or three sutures being placed on either side, and one below at the lower end of the incision so as to shut off the tissue behind the pubes. I attach the greatest importance to this step as most helpful in preventing urinary infiltration, the chief danger of this operation. Two or three carbolized-silk sutures are then inserted in the linea alba above, and cut short, and three or four more to draw the edges of the skin together (Fig. 149). A large Thompson's supra-pubic tube should be inserted for thirty-six or forty-eight hours. After this, a tube may be dispensed with, and the patient turned on his sides for a few hours alternately.

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* If, instead of exactly hitting off the linea alba at once, the surgeon exposes fibres of a rectus or pyramidalis, he should go straight on through these with a director. Any prolonged search for the linea alba will leave frayed fibrous tissue, which will slough tediously, and become coated with phosphatic deposit if the urine be ammoniacal. If the muscles are thus torn through, it must be remembered that they lie on the fascia transversalis; there is no sheath behind them.

† M. Guyon in his second case met with most profuse hæmorrhage: "Nous essayâmes, mais assez vainement, à nous opposer à l'evahissement de toute la plaie par une nappe de sang sans cesse renouvelée." After repeated and fruitless attempts to arrest this hæmorrhage, the bladder was opened and the stone removed. The hæmorrhage ceased entirely on the removal of the rectal bag. The patient, aged sixty-nine, died with purulent infiltration of the sub-peritonæal connective tissue.

Question of Sutures in the Bladder.—I have not used these in any of my ten cases. Whether their use is advisable or not is as yet unsettled. I am very strongly of opinion that they should never be used (i.) where there is cystitis—the urine was ammoniacal in seven of my cases; (ii.) where the bladder is irritable or thickened; (iii.) where the stone is large; (iv.) where the extraction is delayed or difficult, or (v.) where there is any reason to expect bleeding: in such cases the clots will cause violent tenesmus, and, probably, giving way of the sutures. I cannot but think that sewing up the bladder runs a great risk. If sutures are used, either the voluntary powers of expulsion or the catheter must be trusted to. If the former fail and the latter be trusted to, there is much risk of the catheter becoming blocked, and of the lesser evils of urethritis and cystitis, especially with the delicate mucous membranes of children. In either case, whether the instrument is left in or not, it seems to me most likely that, either by plugging of the catheter or by this not being passed just when required, some urine, perhaps septic, may be forced out between the sutures before the bladder wound is firmly closed, a process which must take two or three days. If this extravasation should take place deep down in a wound like this, especially when the superficial part is closed, there is the gravest peril of a fatal issue from purulent infiltration of the connective tissue of the pelvis and abdominal wall. This leakage took place on the third day in three cases of Mr. Pollard's (*Brit. Med. Journ.*, 1889, vol. i. p. 73). In two catgut was used, in the third silk. The patients were boys, aged ten, eleven, and seven. Mr. Bond (*loc. supra cit.*), in three out of the four cases in which he sutured the bladder, found that urine escaped on the first occasion of passing water after the operation. This did not delay union, which appeared to be complete in thirty-six hours. It should be noted with regard to this leakage, that it is carefully stated that the escaping urine was acid and normal.

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* The spot chosen must not be too low or infiltration may take place into the cavum Retzii behind the pubes; if too high, drainage will be interfered with and the peritonæum endangered.

Mr. Bond raises another point which is well worth future noting with regard to the after-condition of the wound, which has been allowed to close by granulation, as one of his patients complained for some months after the operation of a dragging sensation above the pubes when he emptied his bladder. Mr. Bond is inclined to think that the granulation process may undeniably bind and anchor the bladder to the abdominal wall. I have never seen myself nor heard of this result, and as the bladder, whether sutured or not, tends to sink down behind the pubes. I should think that this patient's discomfort was quite exceptional.

I do not wish to appear to forget such a case as that of Dr. Pilcher, who, after supra-pubic lithotomy in an adult, sutured the bladder and used a catheter till the ninth day. The patient went out on the eleventh, and was shown to the New York Medical Society on the fourteenth day, "primary union having taken place throughout the whole extent of the wound, without unpleasant symptoms of any kind." Mr. R. W. Parker has had an equally successful case in a child aged three.* But, however satisfactory it may be thus to shorten time and trouble, I cannot but think, for reasons already given, that the risk run is greater than any advantage gained. Where the suture is used, the directions at p. 778 will be useful.†

A few words may be said here about *the peritonæum.* With such distension of the bladder and rectum as has been advised, with an incision not begun too high up and carried well down over the pubes, with a moderate incision into the bladder, it is most unlikely that anything will be seen of the peritonæum. It may be very indistinctly felt at the upper part of the wound, but this is usually all.

If, after careful distension of the rectum and bladder the peritonæum still seems to encroach too far upon the anterior surface of the bladder, it may be pressed upwards and held out of the way by one or two fingers of an assistant, or, if needful, gently peeled upwards off the bladder with a steel director.‡ In elderly people with lax tissues and large stones requiring free incisions, the peritonæum covered with its fatty tissue is more likely to be seen rising and falling in the upper angle of the wound.

If, what is most unlikely with the recent improvements in the operation, the peritonæum should be punctured before the bladder is opened, the puncture should be picked up and tied around with fine silk or chromic gut. If the opening is more than a puncture the cut edges of the peritonæum should be sutured to the edges of the external wound, and the bladder not opened for three or four days (Bruce Clarke, *Brit. Med. Journ.*, 1890, vol. i. p. 240).

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* There have been several others. Mr. Anderson, of Nottingham (*Lancet*, 1890, vol. i. p. 898) sutured the bladder in a boy, aged ten. Acute pneumonia complicated the after-treatment, and on the night of the fourth day (the superficial sutures being removed and the wound healed) prolonged coughing tore open the wound. The case did well.

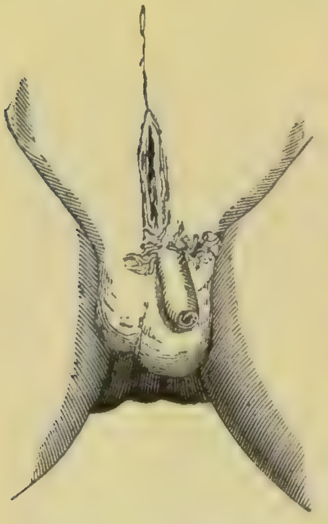
† In an exceptional case under Mr. Page, of Newcastle (*Brit. Med. Journ.*, 1889, vol. i. p. 129) primary union followed, though the vesical wound was not sutured. The wound was found healed when looked at, for the first time, on the fourth day. The patient was a boy, aged eight.

‡ In only one of my ten cases did I have any trouble with the peritonæum. In this case, an elderly patient of Dr. Burton's, of Blackheath, with two lithic acid calculi, each weighing 1 oz., the peritonæum almost reached the level of the symphysis. It was, however, easily raised up off the bladder and thus held with a retractor. I closed the upper part of the wound carefully over it, and sutured the edges of the bladder to the deep part of the wound. A good recovery followed. At the Congress of German Surgeons in 1886, Gussenbauer, Sonnenberg, and Kramer mentioned cases in which the peritonæum was found adherent to the symphysis. In one case it was opened with fatal results; in another, the opening was sewn up and the peritonæum safely separated from the pubes.

If the opening is made after the bladder is opened, the surgeon must decide, according to the amount and character of the urine which has escaped, between suturing the opening and enlarging it upwards, so as to thoroughly sponge out or cleanse by irrigation with a 2 per cent. solution of boracic acid, the peritonæal cavity. But these accidents are most unlikely nowadays.

D. **The After-treatment.**—A little iodoform should be dusted in and around the wound once in twenty-four or thirty-six hours, and iodoform or sal-alembroth gauze and boracic lint applied externally. The trochanteric and glutæal regions should be kept well smeared with eucalpytus ointment. If the above dressings are kept in position with a many-tailed bandage, it only takes a few minutes to renew them. This will be necessary, at first, every three or four hours; in fact, the surgeon who wishes to practise this operation successfully will find that the local after-treatment will give him a good deal more trouble than is usually bestowed on a case of lateral lithotomy, where the patient simply lies on a mackintosh and draw-sheet, and perhaps a lithotomy sponge, with his knees tied together for the first few hours.

Fig. 149.



Supra-pubic lithotomy incision, seven days after the operation. Only the upper part of the wound was sutured.

It is only by suturing the edges of the bladder to those of the wound (p. 921), keeping the wound aseptic by the frequent change of dressings, the use, if needful, of some such fluid as that given at p. 918, and by turning the patient on his side for three hours at a time, after the first twelve hours, as recommended by Sir H. Thompson, that the risks of cellulitis and extravasation can be prevented, the two points in which the operation is said, rightly or wrongly, to be inferior to the lateral method.

I prefer to remove the Thompson's tube about the third day, and then to keep the bladder empty by drainage-tube, which dips into a vessel under the bed. Urine usually begins to come naturally about the seventh day, earlier in children.

I have now operated by this method ten times in the last two years, the patients ranging from three to sixty-two years. Three only of the stones were large. Two were just over 2 oz., a third was 5 oz. In five they were multiple. In seven the urine was alkaline and foul. Two cases were fatal—the sixth, a lad of nineteen, an orphan, in wretched condition of body, and in much misery from pain. Perhaps I should have done more wisely to have waited longer, in order to feed him up before operating. His pain, however, was so severe that I operated a week after his admission into the hospital. He did excellently for forty-eight hours, then symptoms of pelvic cellulitis set in, proving fatal on the fourth day. The other case was one of multiple stones in a man of fifty-eight, much run down in strength. I removed eight calculi, composed chiefly of urates. The patient sank shortly after. His kidneys proved to be in an advanced stage of granular degeneration.

While on some points connected with the operation my mind remains open, I am strongly of opinion that, with carefulness, it is a safer operation than the lateral method for those who only perform lithotomy occasionally, and for large stones—*e.g.*, over 1 oz. I do not think any benefit is to be gained by substituting it for the lateral in the case of children.

MEDIAN LITHOTOMY.

Disadvantages.

1. It gives very little room, and is unsuited to any save the smallest stones.

2. The wound being small, the surgeon cannot bury his knuckles in it or reach the bladder as easily as in the case of the larger lateral wound (Cadge).

3. The rectum on the one hand, and the bulb on the other, are in greater danger than by the lateral method (Cadge).

4. Troublesome bleeding is more frequent (Cadge).

Mr. Cadge, having operated on fifty or sixty cases by the median method, has given it up for the above reasons, and also because his mortality has been rather higher.

Advantages.—Recovery is often extremely rapid; the urine quickly resumes its natural route; and the wound, instead of gaping and healing slowly as the lateral wound does, heals almost by first intention.*

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* Dr. W. T. Briggs, of Nashville (*Trans. Amer. Surg. Assoc.*, vol. v. p. 127), thus sums up the advantages of median lithotomy:—(1) It opens up the shortest and most direct route to the bladder. (2) It divides parts of the least importance. (3) It is an almost bloodless operation. (4) It affords a passage for any calculus

The above do not, however, compensate, in Mr. Cadge's opinion, for the disadvantages. He would avoid it, especially in children, in whom it is by some preferred, as in them a free incision is necessary to facilitate the passing of the finger into the bladder, while here the limit of space for the knife is very small indeed.

The operation is suited for prostatic calculi, but, if these are associated with any larger one in the bladder, the surgeon must either crush this before he can extract it through his small incision, or perform a supra-pubic operation.

Operation.—If a curved* staff be used, one with a wide groove is chosen, and passed and held with its handle inclined towards the umbilicus (p. 907), the patient being in lithotomy position. The surgeon passes his left forefinger into the rectum so as to steady with its tip the staff in the membranous urethra and also to guard the rectum from puncture, while at the same time note is taken of the depth of tissues between the knife and the finger. A straight and very sharp bistoury is then pushed, with its back downwards, through the skin, ½ inch above the anus, straight on into the groove in the staff, which is now held well hooked up against the pubes. The knife, having distinctly exposed the groove, is pushed a little onwards so as to nick the apex of the prostate, and next, as it is withdrawn, it is carried upwards in the raphé so as to divide the soft parts for 1 inch or more according to the size of the stone. The finger would now be passed into the bladder and the staff withdrawn. As, however, the staff occupies too much room in the limited wound to allow of this, a director is passed in along the groove, the staff withdrawn, and then the finger introduced along the director through the neck of the bladder. This is dilated sufficiently, and the scoop or forceps introduced.

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which can be safely extracted through the perinæum. (5) It affords the best passage for the fragmentation of unusually large calculi. (6) It reduces the death-rate to a minimum. In answer to the objection to the median operation that it is unfitted for the extraction of large stones, Dr. Briggs states that by making it a medio-bilateral operation (*vide infra*), as large stones can be removed by it as can be extracted by the lateral method. Since adopting the above modification, Dr. Briggs has had the following excellent results:—Of the first seventy-four, none died. Then two died, but one of these had a pelvic abscess before the operation, and the other died at the end of three months with phthisis and the wound unhealed. Since then Dr. Briggs has had forty-six cases with one death.

[*] Mr. Erichsen recommends a rectangular staff, the angle of which rests against the apex of the prostate, and is thus much easier to find in the perinæum. This special staff is, however, often difficult to introduce, and a curved one, held so as to project its curve in the perinæum, will be easily found.

Some surgeons prefer to make the incision from above downwards, but cutting from below upwards would seem better to protect the bowel.

If a straight staff be used, the surgeon, introducing his knife as above, and having cut upon the staff distinctly both to himself and the assistant who is holding it, takes it into his left hand, and, having brought it down into an oblique position, runs his bistoury along the groove so as to nick the prostate ; the enlargement of the wound and the rest of the operation are conducted as above.

Where the stone is too large to be extracted by the ordinary median operation, the medio-bilateral modification introduced by Gouley, 1828, and used so successfully in America by Dr. Briggs, should be employed. It consists in making, after a longitudinal incision in the raphé, a slight bilateral cut in the elastic ring at the neck of the bladder and the prostate.

Complications and Causes of Death after Lithotomy.—1. Shock.—This is rarely severe, save in patients much pulled down, and after prolonged operations. Children as a rule, however reduced,* rally well after the operation (Sir J. Paget, *Clin. Essays*, p. 404). 2. Hæmorrhage.—If milder methods fail, this is best met by plugging the wound with the umbrella-plug, or by leaving *in situ* a pair of Spencer Wells' forceps, which will also aid the drainage. 3. Pelvic cellulitis.—This, the most frequent cause of death, is due either to extravasation of urine, probably septic, or to laceration of the deep parts, or both. It usually comes on within forty-eight hours. 4. Peritonitis.—Usually combined with the above. 5. Septic complications.—Septicæmia may occur early with pelvic cellulitis. Pyæmia, on the other hand, may come on later. 6. Surgical kidney. 7. Retention of urine.—Common enough a few days after from swelling of the parts. Rarely more serious. 8. Suppression of urine. 9. A sloughy phosphatic state of the wound. 10. Sloughing of the rectum (p. 912). 11. Cystitis.—Rare. 12. Epididymitis. 13. Such causes as tetanus. Later complications, rare, but troublesome:—14. Fistula. 15. Incontinence. 16. Sterility.

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* Occasionally, however, even nowadays, where the history is of long standing and the kidneys much impaired, they are too far gone for operation. See a case by Mr. Hutchinson (*Clin. Surg.*, pl. lxxvi. vol. ii. p. 126).

LITHOTRITY—OPERATION WITH SEVERAL SITTINGS —RAPID OPERATION WITH ONE SITTING AND EVACUATION.—LITHOLAPAXY.

Choice of Operation—Lithotrity or Lithotomy.—It is hoped that the followimg points, while they do not in the least exhaust the subject, will be found of practical assistance.

1. Amount of experience of the surgeon.—Every attempt should be made to become familiar with the use of the instruments, both outside the body and also by passing a lithotrite for examination of a calculus whenever one is felt on sounding. No surgeon who has not had abundant opportunities of practising the needful manipulations will do wisely in attempting to crush a hard stone which weighs an ounce.

2. Size, kind, and number of stones.—As to size, up to 1 oz. or 1½ oz., it is probable that, with the majority of stones, in fairly practised hands, lithotrity is immensely superior to lithotomy as far as immediate mortality is concerned. I use the term "immediate" advisedly, because of the more frequent recurrence, with its results, after lithotrity, and would refer my readers to the remarks on this point at p. 931. With calculi from 1½ to 3 oz., to quote Mr. Cadge's words, "it yet remains to be seen whether lithotomy by any method can be applied with more safety and success than lithotrity."

The difficulty of a decision sometimes met with here is well expressed by the words of Sir W. Fergusson, that the greater is the experience of the surgeon the greater will sometimes be his doubt.

Sir H. Thompson, speaking of hard calculi and litholapaxy (*R.C.S. Lect.*, 1884, p. 127), states that the largest he has dealt with weighed 2¾ oz., the operation lasting seventy minutes. As the outcome of a very especial experience, the same Lectures show (p. 138) that with Sir H. Thompson the proportion of lithotomy to lithotrity has fallen from 1 in 4 to 1 in 30.

More important than the size of the stone is its composition. There is, of course, no comparison between a pure lithic acid or oxalate of lime stone on the one hand and an alternating stone with a good deal of phosphate or urates in its composition, as a test of skill and endurance both on the part of the surgeon and his instruments. Dr. Hingston,* of Montreal, points out that sometimes the apparent softness of a stone is most misleading. Having found an enormous stone in a patient, he employed lithotrity, as the stone seemed soft. After getting away a large quantity of phosphatic matter, he was driven to perform lithotomy, and removed, by the lateral method, a calculus weighing over 5 oz., consisting mainly of oxalate of lime and uric acid.

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* *Intern. Encycl. of Surg.*, vol. vi. p. 311, in his article on Lithotrity.

There are several fallacies in addition to the above in gauging the size and number of calculi. Thus the lithotrite may again and again seize a stone which only weighs ½ oz. in its long diameter, if flattened, of 2 inches. Testing by passing a staff around or rubbing it over a calculus is often most fallacious, and examining per rectum may, if the bladder be thickened, give evidence of a stone apparently much larger that it really is. Mr. Cadge (*loc. supra cit.*) points out a fallacy with regard to multiple stones. "When more than one stone is present, it is customary to seize one, fix it in the instrument, and proceed to sound afresh; this, however, may mislead, for a stone, having been grasped by the tips of the blades and moved about in the bladder, will sometimes rotate a little in the blades of the lithotrite and communicate a grating feel to the hand which is very like touching a second stone."

3. Condition of the urethra.—Two points have to be considered here—(*a*) how far will the urethra *admit* instruments, *i.e.*, how far is its canal normal or diminished by stricture; (*b*) how far, even if normal in calibre, will the urethra *tolerate* instruments. With regard to the first, a stricture, if admitting of dilatation, is not an obstacle to lithotrity; on the other hand, an old stricture with surrounding induration and fistulæ, or a less severe form which produces rigors and fever at each attempt of dilatation, are best submitted to lithotomy, which gives the best chance for the stone, and at the same time offers the much-needed relief of rest to the stricture. Mr. Cadge gives the following practical hint in these cases of stone combined with stricture:—"Sometimes a stone is detected in the urethra behind the stricture, as well as one or more in the bladder, or it may be partly in the bladder and partly in the urethra, and in these cases median lithotomy will not only remove the stone, but may go far to remedy the stricture by external division."

With regard to an irritable urethra—*i.e.*, one without a stricture and only admitting instruments with the aid of anæsthetics—the chief points to consider are the size of the stone and the ability of the surgeon to deal with it by litholapaxy. If the calculus cannot be evacuated at once, or require more than one sitting, lithotomy should be preferred, owing to the results of the passage of instruments and prolonged voiding of fragments.

4. Condition of the prostate.—An enlarged prostate is of great importance, not only from its power of obstructing the operation, but from the changes which it brings about in the bladder. Thus it interferes with the efficient use of instruments, the picking up of a stone even with blades reversed, and the finding of the last fragment. Again, the use of the lithotrite and the passage of evacuating tubes readily lead to hæmorrhage, and this again by clots prevents the free and easy use of the evacuator. Later on, phosphatic deposit, imperfect evacuation, residual urine, and recurrence of stone symptoms are all frequent accompaniments of enlarged prostate.

5. Condition of the bladder.—Formerly it was held needful to operate with several ounces of fluid in the bladder, and some suggested to draw off the urine and inject 8 or 10 oz. of fluid. This amount has now been reduced to something more like 4 or 6 oz. As, if the urine is healthy, no fluid is more suited to the bladder, the surgeon should content himself with following Sir H. Thompson, and "ask the patient to retain his urine for a little less than his accustomed period before the sitting; that is, if he is naturally able to retain his urine for about an hour, he is requested to pass it forty minutes before the time of the visit."

Some other changes in the bladder require mention. (*a*) Sacculation pouches or sacs, whether mere hollows behind or at the sides of an enlarged prostate, or hernial protrusions of the mucous membrane between the muscular fibres, may be the starting-point of calculus by entangling débris or tiny fragments. In Mr. Cadge's words: "The imprisoned fragment first fills up the cyst, then, by continual accretion of phosphates, it grows up into the bladder like a mushroom, and is probably again and again nibbled off by the lithotrite, each time with temporary benefit, until the patient dies, worn out with chronic cystitis and pyelitis." Mr. Cadge goes on to say: "By turning the aperture of the evacuating catheter towards these pouches, aud by the free use of the aspirator in all directions, the fragments may be washed out of them and all removed, but it cannot be denied that it is always a serious matter to shatter a stone into innumerable fragments in a bladder of this description." (*b*) Atony, whether with or without an enlarged prostate. The importance of this is obvious, as tending to recurrence of stone by some small fragments not being expelled in spite of the vigorous use of the aspirator, and also to cystitis from imperfect emptying of the bladder.

6. Condition of the kidneys.—Here I may again quote a veteran's opinion, that of Mr. Cadge: "What is to be said of stone complicated with kidney disease, such as albuminuria and chronic pyelitis and atrophy? In these cases all operations are fraught with danger, but it is probable that the least danger will be met with from a carefully conducted one-sitting lithotrity. So, too, in those cases of constitutional disease combined with stone, such as diabetes, tabes, and other spine disease, it will be well to avoid the shock and hæmorrhage of lithotomy, and proceed, if any surgical proceeding is allowable, by lithotrity." The surgeon, in considering an operation in any of the above diseases, will weigh well the size of the stone, his ability to cope with it at one sitting, and the amount of suffering which it causes the patient.

7. Age.—Here, especially, age is not to be reckoned by years alone.

Recurrence.—As no one, to my knowledge, has spoken out on this subject with such helpful candour as Mr. Cadge, with his experience of 300 cases of stone, I make no apology for quoting once more from his writings (*Brit. Med. Journ.*, July 3, 1886): "Although the immediate and direct mortality of lithotrity is small, the recurrence of stone is lamentably frequent. In my own list of 133 cases, there were 18 in which recurrence, one or more times, took place, being about 1 in 7. Sir H. Thompson, with a much larger number of cases, gives about the same proportion. I am disposed to infer, however, that recurrence is more frequent even than this, because it is not likely that all who get relapse apply to the same surgeon again. Living, as I do, in a local centre, and drawing cases chiefly from a limited area, I am probably more able to trace, and more called on to treat, those who suffer a second and third time, than he who lives in the metropolis and draws his cases from great distances. Patients may, and frequently do, apply to the same operator once or twice; but, after a time, they either apply to their own surgeon, or they decline further treatment, and too often their subsequent history is one of painful endurance of chronic bladder disease and gradual exhaustion. If, moreover, there be added to the list those numerous cases of phosphatic deposit or concretions so frequently noticed after lithotrity, the relapses would, I believe, reach to nearly 20 per cent. This seems a heavy indictment to bring against lithotrity, but I am afraid there is no gainsaying it; and, if so, it would be wrong to pass it over or make light of it. Many of these relapses might be prevented if the patients would observe directions and persevere with treatment. It certainly is so with the unenlightened and uncomplaining hospital patient. Feeling himself well, or what he considers well, he goes to his work, and neglects the use of the catheter and other means; and, instead of returning in a month or so to have his cure certified, or a minute remaining fragment removed, he toils away as long as he can, and returns, perhaps in a year or two, with a fresh uric-acid stone, or with chronic cystitis and a phosphatic one. The educated, sensitive, private patient, on the other hand, will watch his symptoms narrowly, and return if the slightest indication of the old mischief should reappear. . . . . This frequent recurrence must be due either (1) to the descent of a fresh stone from the kidneys, or (2) to a fragment of stone having been left at the first operation. As to the descent of a fresh stone: there can, of course, be no doubt as to the occasional occurrence of this cause, just as we see it occur after lithotomy. The bladder being entirely cleared of stone, there will be the same liability to the descent of a fresh renal calculus after one operation as after the other. What then, let me ask, is the fact as to lithotomy? I have already shown that there were only 21 cases out of more than 1000 of lithotomy at the Norwich Hospital in which recurrence was clearly traced to perfectly fresh formations coming, like the first, from the kidney, or about 1 in 50; whereas, in Sir H. Thompson's list of about 600 persons treated by lithotrity, he mentions 61 cases in which he operated twice, 9 three times, 3 four times, and 2 five times—75 in all, or about 1 in 8. The inference from these data seems to me to be inevitable that relapse of stone after lithotrity is chiefly due to other causes than the descent of a fresh stone. To my thinking, the majority of recurrences is caused by the great difficulty in ensuring the complete removal of all the débris; I have already referred to this in old persons with enlarged prostate and feeble atonic bladder, and it is this class of patients who are especially liable to relapse." Mr. Cadge goes on to show that the tendency to phosphatic deposit after lithotrity is not due to vesical incompetence and residual urine alone without some overlooked fragment, and that the improved method with repeated washings will still fail to discover a last fragment in some bladders.

Operation (Fig. 150).—The preparatory treatment has been much simplified. It is now recognized that the best course is to remove the stone: previous passage of sounds, and injections of the bladder,* are now but little used. A few days' rest, bland unirritating liquid diet, mild aperients, and securing sleep are the chief indications.

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* The amount of urine to be held, in most cases, has already been mentioned (p. 930).

The instruments required will be gathered from the following account. The patient being anæsthetized and lying on a firm couch or mattress close to the right side of the bed or table, with his pelvis raised, and body and limbs well protected from chill, the surgeon, standing on the right side with his instruments close to him, introduces his lithotrite. In doing this care must be taken not to get the blades hitched either just in front of the triangular ligament or in the roof of the prostatic urethra. This will be secured by not depressing the instrument till very late—in fact, not till it is just about to enter the bladder. The instrument, well warmed and oiled, is held at first horizontally over the groin or abdomen, the penis being drawn over it, the shaft being all the time gradually brought into the vertical position as the instrument finds its way by its own weight into the bulbous, membranous, and prostatic urethra. Now, and not before, the handle is somewhat depressed, and the instrument glides quickly into the cavity of the bladder. If the prostatic urethra is enlarged and lengthened, the surgeon may think that he has reached the bladder, but the fact that the gentlest lateral movement of the lithotrite is interfered with will show him his mistake. Pressure with the instrument is alone allowable at the meatus; some rotation may be called for in guiding the instrument through the triangular ligament or past an enlarged prostate. In this latter case also the handles must be further depressed, and a finger in the rectum may give help.

When the lithotrite has entered the bladder it should be allowed to slide, very gently, down the trigone, being now held very lightly so as at once to detect the site of the stone, which it now often touches, but must not displace.

If the stone is felt on one side, the instrument is gently turned to the opposite one, opened, and then turned towards the stone. If it be not felt, the handles of the instruments being slightly raised, and the blades very gently depressed and then opened, the stone will often drop into them.

If this fail, the instrument is turned, open, first obliquely, then more horizontally, first to the one side, then to the other. In the event of the stone still eluding the lithotrite, which is most unlikely, it should be sought for with blades depressed. To effect this, the blades, closed, are raised off the bladder floor by depression of the handle, carefully reversed, and then depressed again so as to sweep lightly over the floor. They are then gently opened and closed, vertically first and then obliquely, so as to complete the examination.

During the above, the following points must ever be borne in mind:—

(*a*) The handle and shaft of the lithotrite are to be kept as steady as possible, so as not to jar the sensitive neck of the bladder needlessly.

(*b*) All movements are to be executed at or beyond the centre of the vesical cavity, the proper area of operating, without hurry, rapid movement,* or any other which partakes of the nature of a jerk or concussion (Sir H. Thompson, *loc. supra cit.*, p. 296).

The male blade is never to be brought into contact with the neck of the bladder, unless this is rendered necessary by the position of the stone.

The stone being seized by one of the above manœuvres, the button † moved, and the screw connected—the screw is gradually turned at first to make the jaws bite, since a sharp turn at this time may drive the stone out either to right or left—the calculus is then carried to the centre of the cavity, which will show whether a fold of mucous membrane has been seized. As the screw is applied more and more forcibly, one or other of the following will be noticed. If not well caught, and if hard, it will be pushed out of the jaws; if a hard calculus and well gripped, it is felt to split into fragments; if soft, and held, it crumbles down. If extremely hard, as a pure lithic acid or oxalate, any attempt at advancing the screw is met by this distinctly recoiling instead of advancing. Each surgeon must now decide for himself, according to his knowledge of his instruments and reliance on his power to deal with large hard fragments, whether to continue or at once to perform lithotomy. If he continue, the resistance will be felt to give way, in the case of a very hard stone, by a sudden sharp crack; in one less hard, more gradually. In overcoming much resistance the surgeon either screws up the male blade as hard as he can and keeps it so, or, having gently unscrewed it a little, screws it up again with a series of light jerks so as to communicate blows to the stone. Cracking of the stone having taken place, the fragments will usually fall close to the original site.

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* "Rapid movements produce currents which keep the stone more or less in motion, so that it is less easily seized than when the surrounding fluid is in a state of rest" (Thompson).

† In this respect Prof. Bigelow's lithotrite seems inferior to Sir H. Thompson's, the working of the button in the latter being smoother and less vibrating.

Thus the lithotrite has only to be kept as immovable as possible to ensure, on drawing out and again closing the male blade, the seizure of a fragment.* This is crushed, and the process repeated again and again till sufficient débris is formed. The lithotrite is then withdrawn firmly screwed up.

An evacuating straight or curved† tube, No. 16 for a stone of moderate size, and 18 for a large one, is then introduced, the evacuator, filled‡ with a warm solution of boracic acid or dilute Thompson's fluid (p. 918), is connected, the meatus being first incised with a narrow probe-pointed bistoury downwards by the side of the frænum if needful. While his left hand supports the evacuator, with his right the surgeon gently but quickly squeezes the bag with sufficient force to send in about 2 oz. of fluid. On relaxing the pressure an outward current takes place, bringing with it crushed fragments. Sir H. Thompson recommends that, after the bag has expanded and the current apparently ceased, the surgeon should wait a few seconds, " as at that precise time it is quite common for one or two of the larger fragments to drop into the receiver which would have been driven back perhaps by too rapidly resuming the pressure."

If, after several washings, the outflow stops, and the bag no longer expands, the end of the evacuator is blocked either by a fragment of stone, or a small calculus, a clot of blood, or the mucous membrane of the bladder. If it be a fragment, as is usually the case, or a clot, dislodgment may be effected by sending in quickly a gush of fluid, or by the use of a gum-elastic stylet, after unscrewing the tube. Impact of the bladder generally takes place when a curved evacuator is turned upwards, and when the bladder is empty. The sensation given may be a kind of flap, simulating the click of a fragment; more often it is a dull vibrating thud, easily recognized. More fluid must be at once injected.

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* It is not always easy to distinguish between a piece of soft stone enveloped in concrete mucus and the lining membrane of the bladder.

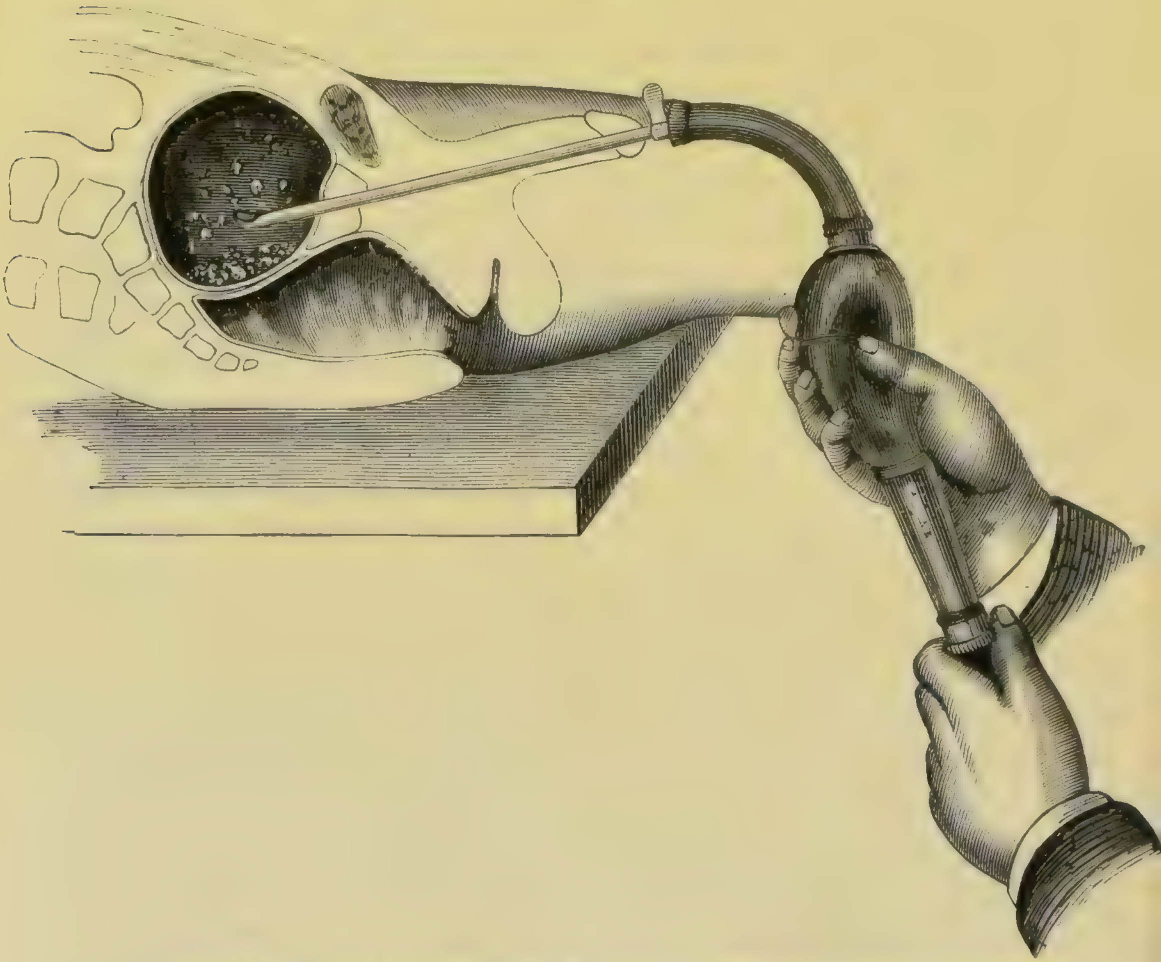
† The tube, if curved, should be held downwards at first, but not quite on the bladder floor; then to one side or the other; then upwards, washings being carried on at the time that these movements are made. A straight tube should lie with its orifice just within the neck of the bladder.

‡ Dr. Keyes (*Intern. Encycl. of Surg.*, vol. vi. p. 244) gives this precaution as to getting rid of air entirely: "The urine, having trickled away through the tube, leaves the latter full of air, an element fatal to nicety of washing. This air may be disposed of most simply. The tube is withdrawn until its eye is in the prostatic sinus, the washing-bottle is attached, and the stop-cock turned, but no further suction made. In an instant, the air contained in the tube is heard ascending through the stop-cock and mounting into the top of the evacuator, where it does no harm, and whence it cannot possibly return into the bladder."

If a large fragment is felt striking against the tube, or if the surgeon is certain that several good-sized fragments remain, he removes the tube and evacuator, and, while an assistant withdraws the blood-stained fluid and fragments and re-charges the evacuator, he introduces a small lithotrite and crushes up sufficient débris to go on again with the washings.

All the time the surgeon must keep before his eyes a mental picture of the interior of the bladder, perhaps diseased, the ureters, perhaps dilated, leading up to kidney pelves enlarged, and remember that the effects of any squeeze of his hands are felt, not only all over the bladder, but perhaps in the ureters and kidneys as well.

FIG. 150.*



The operator is here supposed to be sitting between the thighs of the patient. The expansion of the compressed bulb will aspirate a part of the abundant débris suspended in the fluid. The fragments, being too abundant, have been dispersed. (Bigelow.)

Detection and Seizure of Last Fragment.—This is, as is well known, a matter of much difficulty, owing to the facility with which small fragments get hidden in some folds of mucous membrane or enveloped in blood-clot. As long as there is any "clicking" against the tube, the surgeon must persevere in his attempts at complete removal. If, after several washings, nothing comes out into the receiver, the surgeon should listen carefully over the bladder, as thus advised by Dr. Keyes*: "The tube is turned in various positions, and the operator listens. The swash of the water as it rushes in and out is heard with startling distinctness, and, if the management of the tube is skilful, any fragment of stone lying loose in the bladder is sure in a short time to be driven against the metallic tube so as to announce its presence by a characteristic click, quite distinct from that emitted by the flapping of the bladder wall against the eye of the instrument. Fine sand and thin scales of stone make no sharp click, and all such may be left to pass by nature's efforts, but any piece large enough to require the lithotrite can hardly escape detection by the educated ear."

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* The above evacuator is now old-fashioned. Mr. Golding Bird's pattern, or Mr. B. Hill's modification of Clover's, will be found the most handy.

Time occupied in Litholapaxy.—This may be, on an average, from half an hour to an hour and a half. Prof. Bigelow (*Amer. Journ. Med. Sci.*, January 1878) operated continuously for upwards of three hours, removing 744 grains, the patient making a good recovery. Mr. R. Harrison (*Brit. Med. Journ.*, August 10, 1882) removed a 2½ oz. stone in two hours and ten minutes. Sir H. Thompson (*Syst. of Surg.*, vol. iii. p. 298) says that it is rarely needful to prolong an operation beyond fifty or seventy minutes.

The Old and the New Operation of Lithotrity briefly contrasted.—Old lithotrity advocated short sittings, brief use of instruments, and left the expulsion of fragments, &c., as much as possible to nature. It probably requires less skill, and, in Mr. Cadge's words, "is gentler, milder, less formidable altogether; no anæsthetic is probably required; no extra assistance. . . . A nervous timid patient may prefer this to the more heroic and rougher, if more expeditious, method." It might be added that it is less tiring to the surgeon. But these advantages are trifling as compared with its disadvantages, which are done away with by the new operation, of which the chief are the prolonged passage of fragments, often rough and angular, along a bruised urethra.

The new method of litholapaxy, introduced by Prof. Bigelow, resulted from, and was led up to by, several achievements of modern surgery. Without anæsthetics, without the knowledge of the large instruments admitted by the urethra, without the pitch of perfection and power to which modern instruments have been brought, litholapaxy would still be an impossibility. Owing to its brilliant success, and the rapidity with which it relieves the patient, the single-sitting method has practically rendered the other obsolete.

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* *Loc. supra cit.*, p. 246. The whole of this account, with its vigorous life-like language, will well repay perusal.

After-treatment.—The chief points here are: rest in bed, the patient turning on his side to pass water, for the first few days; hot fomentations to the abdomen, and hot bottles at first; morphia subcutaneously, if indicated; warm milk, barley-water, mineral waters or lemonade, a little whisky or brandy being given, if needful: all chills should be carefully avoided.

In addition to the above, the putting the patient frequently in hot hip-baths for a quarter of an hour, the occasional passage of a soft catheter, and the rendering the urine alkaline, will give much relief. The urine should always be strained through muslin to collect the débris.

Complications during Lithotrity and Litholapaxy.

1. Escape of Urine.—This may take place during or after the passage of the lithotrite. The penis should be compressed against the lithotrite, and a pause made while the patient is got more fully under the anæsthetic. If this fail, tying a tape round the penis and instrument, injecting a little fluid, or putting off the operation till the bladder is in a more fitting state after the use of instruments, injections, and such drugs as belladonna and subcutaneous injections of morphia, may be made use of.

2. Hæmorrhage.—Sufficient blood to stain the fluid in the evacuator during the operation, and the urine for a day or two after it, is not uncommon. If the hæmorrhage during the operation is severe, the surgeon must decide whether it is due to the damage to the bladder or urethra, to his having scratched the latter by withdrawing a fragment in the evacuator's eye, to bruising of an enlarged prostate, or to co-existent growth. In this last case the supra-pubic operation will probably have to be performed either at the time or later; in the other cases the surgeon must decide on completing or deferring the crushing by the amount he has already effected, his experience, and the amount of the bruising inflicted.

3. Clogging or Fracture of the Lithotrite.—Clogging or impaction is liable to happen with a non-fenestrated instrument with weak and narrow blades. With one properly made, with as broad blades as possible, and the male one blunt, roughened, and laterally bevelled off, the accident is unlikely. When it occurs, it must be met by percussing the instrument, if opening and closing the blades, and thus freeing them in the fluid, is impossible. If

the impaction persist, the blades must be withdrawn as far as possible by safely maintained traction. If no force that is wise will withdraw them, they should be cut upon in the perinæum, thrust out, unloaded, and withdrawn, and the rest of the stone removed as by a median lithotomy. If, owing to any defect in the instrument, the blades, though not clogged, cannot be screwed up, they must be cut upon as above, thrust through, and, if possible, filed off. If a blade break off, it must either be caught and withdrawn by another lithotrite, or the patient cut at once.

4. Injury to the Bladder or Urethra.

Complications after Litholapaxy and Lithotrity.—These are much the same as those already given at p. 927, as occurring after lithotomy.* The chief differences are the greater liability to rigors and urinary fever, and the greater frequency of epididymitis. Bruising of the urethra has also to be remembered, whether by the instruments, or, after the old-fashioned lithotrity, by the passage of fragments.

LITHOLAPAXY IN MALE CHILDREN.

The advisability of this mode of treating stone is still *sub judice.* It has been strongly advocated by Surgeon-Major Keegan,† who, after a wide experience of large stones in India, is inclined to think that the objections usually made to litholapaxy in boys are not valid. Thus—(1) as to *the smallness of the bladder*, the bladder of a boy of even only three or four is, as a rule, quite roomy enough to permit of the efficient working of a small lithotrite and a medium or full-sized aspirator if gently worked. The bladders of boys with stone are, as a rule, healthy, and will stand more distension proportionately to their capacity than the bladders of old men. (2) *The extreme sensitiveness of the mucous membrane of the bladder and urethra.* Dr. Keegan thinks that, with an anæsthetic, this may be safely disregarded. (3) *The liability to laceration of the mucous membrane of the bladder and urethra.* This objection is, he thinks, a theoretical one only. (4) *The small calibre of the urethra.* Dr. Keegan states that not only is the calibre of the urethra in boys of six or eight not very small, but that of boys of only three or four is sometimes very large.

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* The same want of space that caused me to treat these, above, too briefly, prevents my going into them again here.

† *Litholapaxy in Male Children and Male Adults* (Churchill, 1887); *Lancet*, 1886.

As in men, the true calibre of the urethra cannot be told unless the meatus, which is sometimes very small, is incised. Speaking generally, the urethra of a boy from three to six will admit a No. 7 or a No. 8 lithotrite (Eng. scale), and that of a boy of eight or ten* will admit a No. 10, a No. 11, and even sometimes a No. 14. "With a No. 8 lithotrite and a No. 8 evacuating catheter it is, I find, quite feasible to dispose of a mulberry calculus weighing between two and three hundred grains in an hour's time."†

Dr. Keegan insists upon the completely fenestrated lithotrite as being the only perfectly safe instrument to use, as, with any other, clogging of the blades is a very likely and a most dangerous complication.

In discussing, in the first edition of this book, the advisability of surgeons adopting, as a general rule, this method of dealing with stone in male children, I pointed out (1) that one very important matter, the percentage of recurrence after litholapaxy at this age, had been left undealt with by Dr. Keegan; and (2) that such an individual experience, splendid as it is, can scarcely be taken to furnish a rule to those who only meet with stone at comparatively rare intervals. Dr. Keegan has since written on both these points (*Ind. Med. Gazette*, Feb. 1890, p. 40).‡ It will be seen that, with regard to the first point, the fact that recurrence after litholapaxy in boys in India is so very small, is due to the opportunities and experience, absolutely unrivalled and never to be known in this country, which fall to the lot of surgeons in India, in treating stone in the bladder. With regard to my second point, Dr. Keegan strongly confirms what I wrote. (1) Recurrence of stone after litholapaxy in India. Speaking from an experience of 110 cases of his own, Dr. Keegan has "arrived at the conclusion that recurrence of stone does not follow litholapaxy in male children any oftener than it does lateral lithotomy, provided the former operation be skilfully performed." Dr. Keegan points out that the states of the bladder which favour a recurrence —viz., an organ feeble and atonic, and often hypertrophied, fasciculated, or sacculated, and enlarged prostates—are not met with in boys. With regard to my second point, that such an individual experience, so different to anything that we meet with here, should not mislead those who only meet with stone at comparatively rare intervals to substitute litholapaxy for the eminently safe operation* which lateral lithotomy has been proved to be in boys, Dr. Keegan writes as follows: "I am disposed to agree with Mr. Jacobson in doubting if in Great Britain lithotomy in male children will be replaced by litholapaxy. And why? Because to render himself familiar with the use of the lithotrite, the surgeon must be afforded frequent opportunities of dealing with cases of stone; and as such opportunities occur only at rare intervals to the majority of hospital surgeons in Great Britain, they will therefore very naturally cling to that operation which is performed by aid of the instrument with which they are most familiar, the scalpel."

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* Mr. Walsham brought before the Clinical Society (*Trans.*, vol. xix. p. 240) a case of lithotrity at a single sitting in a boy aged ten. The stone here was very small, weighing 15 grains, and lateral lithotomy had been performed about six months before.

† Dr. Keegan has had constructed by Messrs. Weiss a lithotrite, No. 6 in the stem and in the angle, which will readily pass through the urethræ of the great majority of boys of between two and three, and is perfectly capable of disposing of stones weighing up to 2 drachms. A rather larger one is No. 6 in the stem and No. 8 in the angle. Dr. Keegan advises any one wishing to give litholapaxy in boys a fair trial, to provide himself with a set of completely fenestrated lithotrites running from No. 6 to No. 10 (Eng. scale).

‡ Dr. Keegan in a letter of later date says that his litholapaxies in boys now amount to 125, with only four deaths. In three of these extensive disorganization of the kidneys was proved to exist. In the fourth there were strong reasons for suspecting it.

TREATMENT OF STONE IN THE BLADDER IN THE FEMALE.

Practical Points.—The absence of any prostate or of a fixed smooth trigone-surface is of importance here, especially with regard to lithotrity. The aid given by a finger in the vagina, the dilatability of the urethra, the association of calculi with foreign bodies, are also well known. It is only occasionally that enlargement of the uterus or prolapse of the vaginal wall of the bladder interferes with the treatment of stone.

Operations.

A. *In Adults.*—We have here the following three methods to consider:—

1. **Dilatation.**—When the stone is small—*i.e.*, the size of a filbert, a stone not exceeding $\frac{3}{4}$ inch in its largest diameter—it

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* Mr. Bryant, in writing of the successes which lateral lithotomy has given in children (*Surgery*, vol. ii. p. 106) states that during seventeen years 100 patients had been cut consecutively at Guy's without a death. Another matter deserves mention. Cutting for stone is no longer limited, as of old, to a few great centres. How many institutions in or out of London, how many cottage hospitals, will be provided with the set of special instruments which are necessary.

may be safely removed by rapid dilatation with Weiss's instrument guarded with fine drainage-tube,* followed by a finger (the little one first).

2. **Litholapaxy.**—By this means calculus in the female bladder may be most frequently and efficiently treated. Thus, hard stones under an ounce, and phosphatic ones of a much larger size, may be dealt with at one sitting. The character of the ring or sound with the staff, the bite of the lithotrite, and the condition of the urine will aid here. A shorter instrument will be found much more convenient to work with. Where there is much irritability of the bladder, much difficulty will be met with in keeping fluid in it, owing to the absence of a prostate and the shortness and directness of the urethra. The pelvis must be well elevated, the patient placed fully under the anæsthetic, and the finger of an assistant should make pressure on the urethra. In other respects the operation resembles that already fully given for the male (p. 932). The dilatable urethra admits a full-size evacuating tube.

3. **Lithotomy.**—This operation is called for when the stones are multiple,† when one is too large, especially if mainly hard as well, when there is a foreign body as a nucleus,‡ when there is

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* So as to avoid the risk of splitting the soft parts. It is not meant by the above remarks that much larger stones have not been successfully passed and removed from the female bladder. Thus, Dr. Yelloly (*Med. Chir. Trans.*, vol. vi. p. 574) gives a case in which a stone, weighing 3 oz. 3½ drs., was extracted; incontinence followed. Where large calculi—*e.g.*, of 6 oz.—have come away spontaneously, it has been usually by a process of prolapsus and ulceration combined. We do not yet know what is the greatest dilatation which the female urethra will safely bear. Perhaps the limit given above is, if anything, too small. Erichsen (*Surgery*, vol. ii. p. 1024) gives "8 or 10 lines in diameter" as the size of a stone which can be safely extracted by this means. Sir H. Thompson (*Syst. of Surg.*, vol. iii. p. 308) says "dilatation should never be employed for any calculus larger than a small nut or a large bean in an adult, which limits its application to very few cases." Mr. Bryant (*Surgery*, vol. ii. p. 120) states that, "in children, a stone ¾ inch in diameter, and in adults 1 inch, may be fearlessly removed from the bladder by rapid dilatation and extraction, with the patient under the influence of chloroform. I have removed larger calculi, 2 inches in diameter, by this means, without any injurious after-effect, but it is probably not wise to make the attempt, the surgeon possessing in lithotrity an efficient aid or substitute." Dr. Keyes (*Intern. Encycl. of Surg.*, vol. vi. p. 297) recommends not dilating the urethra more than ¾ inch.

† As in Dr. Galabin's case (*Obst. Soc. Trans.*, April 7, 1880), in which twelve large calculi and about fifty smaller ones were removed successfully by vaginal lithotomy from the bladder of a woman aged sixty-one.

‡ As in the large stone formed round a hair-pin, and figured (p. 579) by Hart and Barbour in their *Manual of Gynæcology*. Here the projection of the hair-pin on either side of the stone would indicate, nowadays, the supra-pubic operation.

great irritability with ulceration of the bladder, or when a growth co-exists.

Of the following methods—(*a*) vaginal, (*b*) supra-pubic, (*c*) urethral, and (*d*) the lateral method of Buchanan—the first two only need be alluded to.

Vaginal Lithotomy.—By this is meant extraction of a stone through an incision in the anterior vaginal wall, behind the vesical orifice of the urethra, and thus not interfering with this canal at all.

This anterior wall is about 4 inches long in the adult; in relation with it is anteriorly the urethra, to be felt as a cord through this wall, behind this the bladder, and farther back the os and cervix uteri. No peritonæum is normally in relation with this wall, as this membrane leaves the uterus half-way down to pass directly on to the bladder. No important vessels or nerves are met with in vaginal lithotomy: but this, though the simplest and easiest of all the methods of cutting for stone, will be but rarely called for, as in all moderate stones in women litholapaxy is usually available, while in the case of larger ones, and with all calculi in female children, the supra-pubic method is indicated, save for tiny stones which can be removed after dilatation. The only drawback of a vaginal lithotomy in women is the risk of a fistula, but this need only be taken into account where phosphatic urine is present, or where the edges of the wound have been bruised during the extraction of the stone. In either case the calculus will probably be a large one or multiple, a condition, as already stated, which is better dealt with otherwise. The following case, which came under my care in 1889, is a good instance of how the operation may be occasionally called for ("Vaginal Lithotomy in a Patient 6½ Months Pregnant; Immediate Suture of the Wound—Recovery; Normal Delivery at Full Time" (*Lancet*, vol. i. 1889, p. 628). A. L., aged twenty-seven, was sent to me by Dr. Montagu Day, of Harlow, December 7, 1888. For three years she had had bladder trouble—viz., hypogastric pain, cystitis, very frequent micturition day and night, with stoppages of the stream, and acute suffering after the bladder was emptied. The patient was extremely timid and nervous, owing to her four confinements having been "tight" and lingering. Craniotomy had been required with the first, and with another labour was induced at seven months.—December 8. The urethra was dilated, and the bladder explored. A calculus, apparently an inch in either diameter, was felt; the bladder was extremely contracted, with its mucous membrane in places raw and bleeding, in others encrusted with phosphates. It was decided, for the reasons given below (p. 945), to perform vaginal lithotomy.—December 10. Twenty-four hours after the exploration the patient had recovered control over her bladder. Chloroform being given, the vagina was thoroughly syringed out with hyd. perch. (1 to 1000), the posterior wall was well drawn down with a duckbill speculum. A straight lithotomy staff (No. 4) was then passed, and the site of the stone determined. A sharp hook was next inserted into the posterior part of the urethra so as to drag the anterior wall of the vagina upwards and forwards. This, however, caused such free oozing that it had to be removed, and sponge-pressure applied. This bleeding was partly caused by the vascularity of the parts due to pregnancy, and partly by that set up by the dilatation of the urethra two days before. A sharp-pointed bistoury, introduced so as to avoid the urethra and neck of the bladder, was carried into the groove of the staff through the anterior wall of the vagina and fundus of the bladder, and then backwards for nearly 2 inches. The gush of urine which at once followed on the withdrawal of the knife carried the stone downwards, and it was extracted with lithotomy forceps with the utmost ease. After the bladder had been explored with the finger, it was repeatedly washed out from the wound * with diluted Thompson's fluid (*a*). Little bleeding had followed on the incision, and it was clear that sutures would entirely control what remained. The vagina having been well sponged out, the edges of the incision, clean cut and without bruising,† were adjusted with six salmon-gut sutures and four of horsehair. The apposition was tested with a fine probe, especially behind, where a little difficulty was met with in inserting the sutures. Owing to the patient's straining at this time, some urine escaped from the urethra, but none came through the wound. The vagina was next thoroughly syringed with a solution of hyd. perch. (1 in 1000), dried out with aseptic sponges, and dusted with iodoform. To secure more certain asepsis, and also to support the wound and sutures, the vagina was lightly plugged with strips of iodoform gauze. Though this was done with all gentleness, it was soon after noticed that blood was trickling from the vagina. On removal of the strips, two small lacerations on the right side of the vagina, near the orifice, the parts here being exceedingly pulpy and vascular, were oozing freely. This was arrested by tying up the bleeding points with chromic gut. The vagina was again irrigated and insufflated, but no further trial of plugging was made. As soon as the patient was replaced in bed, a soft catheter was inserted to empty into a "slipper." The recovery was rapid and without drawback. The ten sutures were removed on the eighth day with the aid of chloroform. The catheter was retained till the twelfth day, when the patient was allowed to get on a sofa. She left the hospital seventeen days after the operation. Dr. Day wrote, on March 19, that the patient had been safely confined without any trouble with the lithotomy incision. The first question to decide here was whether to operate at once or to let the pregnancy (already advanced to six months and a half) be first concluded. While the stone itself was not large enough to have interfered with labour, both Dr. Day and I thought that, if the bladder were allowed to remain in its present state for another two months and a half, the cystitis would be rendered much more difficult of treatment, intensified, as it was likely to be, by a lingering and difficult confinement, such as the patient was liable to. It having been decided that it was advisable to interfere at once, the choice lay between (1) *dilatation of the urethra*, (2) *litholapaxy, and* (3) *lithotomy*.—(1) *Dilatation.* The size of the stone at once put this aside. Though small (240 gr.), it was a full inch in one diameter, and just over ¾ inch in the other. With such a stone (a hard one, of lithic acid and lithates, there was a very serious risk of after incontinence (especially when the blades of a small forceps have to be taken into consideration as well). (2) *Litholapaxy.* If it had not been for the co-existing pregnancy, the stone might well have been thus dealt with. But as great irritability of the bladder was present in addition to the pregnancy, it was thought that litholapaxy was more likely to require a prolonged anæsthetic and to cause greater disturbance of some important pelvic and abdominal viscera than the remarkably simple and rapid vaginal lithotomy. It will be remembered that the way in which the anæsthetic would be taken, and its after-results, were more than ever matters of uncertainty in this case. If the anæsthetic had been badly taken, we had to face the risks, on the one hand, of premature labour coming on, and, on the other, of difficulty in completing the operation, and thus of fragments being left behind, which would intensify the already existing cystitis. (3) *Lithotomy.* It being decided to resort to this, the vaginal method was chosen from its great simplicity, the small amount of anæsthetic required, and the facilities which it gave for washing out the bladder at the time of the operation.

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* It would be wiser to do this from the urethra.

† Under less favourable conditions closing the wound may have to be deferred till the parts are quite healthy.

Supra-pubic Lithotomy.—This has been fully described at p. 915. The fluid is retained in the bladder by finger-pressure upon the orifice of the urethra.

B. *In Children*—Some of the conclusions which Mr. Walsham has drawn in a very helpful paper (*St. Barthol. Hosp. Reports*, vol. xi. p. 129) may be quoted here:—

For small stones rapid dilatation under chloroform is better, as causing less annoyance and inconvenience to the patient. That moderate- and even large-sized stones have been removed by dilatation, but that, as incontinence has frequently followed from over-distension, it is not justifiable to subject the patient to this risk. That, after limited dilatation, should the stone appear larger than was anticipated, it may be crushed with safety; but, should crushing be considered unadvisable or impossible, it is better to perform vaginal lithotomy than subject the patient to any risk of incontinence by over-dilatation. That it is not safe to aid the dilatation by incising the urethral walls. That incision of the urethra alone, without dilatation, in whatever direction practised, is frequently attended with incontinence, and should therefore be abandoned. That moderate and even large stones can be easily removed from young children by vaginal lithotomy, aided, if necessary, by dilatation of the vagina, incision of the fourchette, and crushing of the stone by the wound made through the septum, without any risk of a permanent vesico-vaginal fistula so long as the edges of the incision are not bruised in the extraction.

Mr. Walsham considers each of the above and several other points separately, and supports them with evidence. I think that this tends to show, in the case of vaginal lithotomy, that, though a stone may be thus extracted after dilatation of the vagina, division of the fourchette, and destruction of the hymen, it is by no means easy in these latter cases to insert sutures satisfactorily. It will be wiser, I think, to make use of the supra-pubic operation in female children for all save the very smallest stones. Lithotrity is by no means easy in these small bladders, and the risk of vesico-vaginal fistula has already been shown to be very great.

I would refer my readers to a case of supra-pubic operation by Mr. Barwell in a child aged nine, from whom a stone weighing 2¼ oz. was successfully removed. It is interesting to note that

Mr. Barwell was led to adopt the supra-pubic operation from his having had within seven months no less than three cases of vesico-vaginal fistulæ originating in the extraction of calculi during infancy and youth by different surgeons (*Med. Chir. Trans.*, vol. lxix. p. 342).

CYSTOTOMY.

Indications.—The operation of opening the bladder, apart from such cases as exploring for growth, foreign body, &c., may be required in—

1. Some cases of cystitis. When the urine is fetid and slimy. When pain in the bladder and penis is intense, leading to loss of sleep and appetite. When there is a high temperature and other evidence of imminent septicæmia. When all other treatment has failed, and when washing out is insufficient or unendurable.

The operation here, for the sake of the kidneys, must not be put off too late. Much benefit may be obtained by irrigating the bladder freely, and afterwards mopping it out with a small sponge and a solution of silver nitrate, ʒss or ʒj—℥j.

2. Some cases of great irritability of the bladder persisting after dilatation of a stricture. Mr. R. Harrison (*Surg. Dis. of the Urin. Org.*, p. 201) believes that the continuance of the irritability in these cases is due to the muscular hypertrophy which the bladder has undergone in its constant endeavours to force urine through the obstruction in front of it, and that the cystotomy is curative by bringing about atrophy or loss of that muscularity.

3. Some cases of tubercular cystitis (p. 901). Here the bladder may be drained to give relief from intense suffering; but the relief here is often short-lived, the presence of a tube being resented by the ulcerated bladder. If the tube is dispensed with, the patient cannot be kept dry, and the wound soon closes.

4. As part of other operations. Thus, in plastic operations about the urethra, to keep the parts dry, the bladder may be opened. I have done this in a case of epispadias.

5. As this operation will not again be alluded to, I may remind my readers that cystotomy, or, rather, opening the prostatic urethra on a staff, has been recommended by Sir H. Thompson (*Dis. of the Prostate*, p. 176) in those few but most distressing cases of enlarged prostate leading to hourly catheterism, cystitis, loss of sleep, and other aggravated symptoms.

The above are instances of cases calling for cystotomy. The surgeon will have to choose between three operations—viz., median and lateral cystotomy and external urethrotomy. The median operation is almost always to be preferred to the lateral, but it is probable that external urethrotomy (pp. 896, 957) will be sufficient as to drainage, and it is certain that this operation is less risky from shock, cellulitis, and secondary hæmorrhage. The great object is to drain the cavity thoroughly.

Supra-pubic cystotomy is employed occasionally in Hunter's method of treating stricture by passing a sound from the bladder up to the perinæum.

RUPTURED BLADDER.

The treatment of this hitherto most fatal injury has of late years been cleared up.* Exploratory operations and suture of the bladder will be increasingly successful in favourable cases—*i.e.*, those seen early and those in which the injury is limited to the bladder.

Two forms of rupture are recognized—the intra- and extra-peritonæal. It may be well to state succinctly the symptoms.

Intra-peritonæal Rupture.—(1) History of a likely injury. (2) Inability to pass water.† This power has, however, been preserved in both varieties; naturally it is seen most frequently and more completely in extra-peritonæal cases. It is very rarely normal in the intra-peritonæal ruptures. (3) A little bloody urine drawn off with a catheter. (4) Difficulty of manipulating an instrument in a contracted bladder. (5) If the catheter, hitting off the rent, be passed beyond the bladder, a much larger quantity of blood-stained fluid is withdrawn, partly urine, partly serum, from irritation of the peritonæum.‡ (6) Speedy (usually) supervention of peritonitis. (7) Perhaps fluctuation and dulness in the flanks.

Extra-peritonæal Rupture.—(1) History of a likely injury. (2) Inability to pass water (*vide supra*). (3) A little bloody urine drawn off. (4) The catheter finds the bladder contracted. (5) No tapping of a larger amount of fluid. (6) Evidence of extravasation § rather than of peritonitis.

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* Especially by Sir W. MacCormac's paper, with two successful cases, *Lancet*, 1886, vol. ii. p. 118.

† Thus the rent may be valvular or blocked by intestine, &c. On all these and many other points the reader should refer to Mr. Rivington's writings, *Dict. of Surg.*, vol. i. p. 152 and *Rupture of the Urinary Bladder*, for exhaustive completeness and helpful information.

‡ If the flow through the catheter is markedly increased by inspiration and diminished by expiration, the rent is probably a large one.

§ Thus, if the rent is in front, the urine may be localized there with circum-

It must be remembered that the following may mislead:—There may be very little pain complained of; no sickness; a normal temperature; the patient may be able to walk; upwards of half a pint of urine may be drawn off night and morning, and yet the peritonæal cavity may contain much fluid. Peritonitis may be absent post mortem, though tympanitis be present during life, and though fluid be found in the peritonæal cavity. The patient may live five days, apparently improving, and then die suddenly.

Operation.—The patient being under an anæsthetic, the abdominal wall cleansed and shaved, and the parts relaxed,* a free incision, 5 or 6 inches long in the adult, is made in the middle line. The linea alba being divided, the recti retracted and partly detached if needful, all bleeding-points secured, the lower angle of the wound and the parts behind the pubes are carefully examined for ecchymosis, extravasation, &c. If neither of these nor any collection of fluid is found outside the peritonæum, this is opened, when a large gush of fluid may be decisive. The surgeon now introduces one finger to feel the rent, and the detection of this may be facilitated by passing a short-beaked sound. The rent will vary in site and length,† and also as to regularity, thickening, &c. If it be a long one, and reach downwards towards the recto-vesical cul-de-sac, the introduction of a rectal bag (Figs. 146, 148, pp. 917, 919) may be of assistance. Sir W. MacCormac also found that the bladder came up more readily after the parietal peritonæum had been transversely divided on each side. An assistant with carefully cleansed hands may render service at this time by hooking up the bladder with two fingers, while the intestines are kept back with sponges. The rent, being now in view, is cleansed, and sutures of fine carbolized silk inserted. The shortest possible needle should be employed here, owing to the depth of the wound and the limited space there is to work in. Sir W. MacCormac used sixteen of these in one case and twelve in another, and his success is largely due to the great care with which they were inserted. Thus, they were put in ¼ inch

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scribed dulness; or widely diffused, mounting up towards the umbilicus, between the abdominal muscles and the peritonæum; or passing into the iliac fossæ, or, by the canals, into the scrotum and thighs.

[*] In Mr. Willett's case (*St. Barthol. Hosp. Reports*, vol. xii. p. 209) much difficulty was met with from the rigidity of the abdominal walls, and the great distension of the intestines, which kept crowding out of the wound, and were most difficult to replace. Peritonitis had set in here, twenty-four hours having elapsed since the injury.

[†] In Sir W. MacCormac's cases the rents were 4 and 2 inches long.

apart, after Lembert's method (Fig. 123, p. 788), including the serous and muscular coats only, beginning at the lower part, and the first and last sutures being inserted well beyond the limits of the injury so as to prevent leakage from the extremities. The following precautions are taken in passing them:—Fine curved needles are used on holders; the serous surfaces are carefully inverted. The sutures are passed through the serous and muscular coats only. This avoids the risk of traversing the mucous membrane, which in animals has nearly always proved fatal, because —(1) on tightening the sutures, the mucous membrane falls between the edges of the wound and hinders union; (2) the urine may find a channel through the points of passage of a suture, and so into the cavity of the peritonæum; (3) the loop of suture within the bladder is a foreign body, and salts may be deposited on it.

Wherever a gap appears, another suture should be inserted. If there is time, a few of chromic gut may be inserted through the serous coat only,* but Sir W. MacCormac regards the double row as unnecessary; 8 or 10 oz. of boracic acid are then injected into the bladder, to see if it is water-tight; or a coloured fluid, such as Condy's lotion, may be used. A few more sutures may be required till this fact is absolutely certain. The peritonæal cavity is now most carefully wiped out with sponges on ovariotomy clamp-forceps, pushed well down into the pelvis and the flanks till they come out clean and dry on squeezing. Sir W. MacCormac made use of another method of cleansing the peritonæum which proved simple and efficient—viz., irrigating the peritonæal cavity with 2 gallons of a 1 per cent. solution of boracic acid dissolved in boiled water, and used at a temperature of 98°. The tubing to which the nozzle or catheter is attached should have a stop-cock, that the flow may be regulated. All the fluid should be got out again by turning the patient over, holding the edges of the wound apart, &c.

In one of Sir W. MacCormac's cases a drainage-tube was passed from the centre of the wound into the recto-vesical cul-de-sac. In one case a catheter was tied in; in the other (the slighter case), in which no catheter was left in, urine was passed involuntarily a few hours after the operation; this went on at short intervals till the third day, when the control became complete.

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* Sutures through the serous coat, only, invariably give way.

PUNCTURE OF THE BLADDER.

The following methods will be considered here :—

i. **The Aspirator.**
ii. **Supra-pubic Puncture.**
iii. **Puncture per Rectum.**
iv. **Puncture through the Prostate.**

i. **The Aspirator.**—This may be used in cases of great urgency, when the surgeon is compelled to relieve retention without regard to the cause ; when he is without the means of carrying out other and perhaps better methods ; it is especially suited to those cases in which there is reason to believe that urine will again, in a few hours, be passed by the urethra. Thus, in gonorrhœal retention where a catheter cannot be passed, having perhaps been clumsily used, and where relief is urgently required, where retention has supervened on a stricture of only two or three years' standing, it may be used successfully, giving time for warm baths and opium to act. In an old stricture, in one of traumatic origin, or in a case of enlarged prostate, it can only be a temporary measure, and should only be used when other instruments are not available.

The question arises, *How far will aspiration bear repetition ?* This is quite uncertain. On the one hand, in a case of prostatic retention not admitting a catheter, the patient being throughout in a most grave condition, Dr. Brown (*Brit. Med. Journ.*, May 23, 1874) used the aspirator fifteen times between January 2nd and 12th, " with immediate relief on every occasion, and without the smallest inconvenience or injury from the punctures." Mr. Hague (*Lancet*, 1885, vol. ii. p. 385), in a patient, aged ninety, with prostatic retention of forty-eight hours' duration, aspirated, and continued to do so daily for nearly five weeks, as no catheter could be passed. Such numerous aspirations caused no ill effects.

On the other hand, in a case of mine of prostatic retention in which the aspirator had been used only three times, on the death of the patient from bronchitis on the fourth day, the third and last puncture was found to be leaking. Dr. Campbell (*Brit. Med. Journ.*, February 21, 1886) records a case in which the bladder had been aspirated twice, internal urethrotomy was performed, " progress was good for a day or two, when some inflammation appeared at one of the punctures, an abscess formed, peritonitis came on, and the man died." Where aspiration is to be used, the condition of the bladder walls and of the urine must be taken into account.*

If aspiration be made use of, a fine needle should be employed, and introduced just above the pubes while an assistant steadies the bladder by pressure on either side. The bladder must not be allowed to become much distended before the puncture is repeated, otherwise urine may be forced out.

ii. **Supra-pubic Puncture.**—This operation has the *advantages* of being easily performed, of giving permanent relief if desired, and of being safe.

The two *objections* brought against it are that (1) it gives bad drainage, and (2) it is liable to extravasation.† Neither of these is borne out by facts. While the patient is in bed, good drainage can be provided by turning him on his side and attaching tubing to the cannula; when the patient is up (and a cannula so placed is no drawback to this), the power of micturition will probably have returned. In a few cases of enlarged prostate the patient will be compelled to pass his urine this way for the rest of his life, but as soon as the parts are consolidated around the cannula, or the catheter which has replaced the cannula, micturition, though tedious, will be effected satisfactorily.

I may allude to three cases in which I have used this method in the last six months—two of retention with stricture, one of prostatic retention. I consider it the best all-round method, and the one of widest application that we have. Its relief is immediate, safe, and simple withal. The two cases of stricture were men under forty, admitted with a history of catheterism, bleeding urethræ, and recent false passages. On the fifth day, with the aid of ether, I was able to get a No. 7 silver catheter into the bladder. For some cases of older strictures, especially if with fistulæ and damaged perinæum, a longer rest is required, and Mr. Cock's or Mr. Wheelhouse's operation is indicated.

Operation.—This is most simple. A median puncture being made through the skin just above the shaved pubes, I prefer a curved trocar and cannula,* the latter carrying tape-holes, but a straight trocar and cannula may be used, through which an 8 or 9 gum-elastic catheter, or, better, a Jacques' catheter, is inserted; in four hours the cannula can be removed, and a larger catheter, a 10 or 12, introduced.†

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* Mr. Bennett read a case before the Medico-Chirurgical Society (*Lancet*, vol. i. 1888, p. 418) of extra-peritonæal rupture of the bladder after aspiration in a patient long the subject of stricture. The opinion of most surgeons present seemed to be that aspiration was dangerously liable to leakage, especially in unhealthy bladders.

† Mr. T. Smith (*St. Barthol. Hosp. Reports*, vol. xvii. p. 291) writes: "I have seen no such tendency to extravasation; occasionally there is some inconvenience from leakage; this may be met by leaving out the cannula for a few hours, which allows recontraction to take place.

iii. **Puncture per Rectum.**—This has the advantage of draining a bladder well, but there are such serious disadvantages connected with it that the supra-pubic operation is always to be preferred to it.

Thus, (1) it is difficult and most unpleasant to the patient to retain the cannula during defæcation and passage of flatus—the retention of a cannula is liable to cause troublesome tenesmus and diarrhœa; (2) when the cannula slips out it is difficult to replace it;‡ (3) the patient is kept in bed; (4) this method is not applicable to cases of enlarged prostate. I am aware that Mr. Bryant (*Surgery*, vol. ii. p. 153) states that "an enlarged prostate is no real obstacle to its performance, for this, if necessary, may be perforated with impunity." I cannot at all agree with the above, in spite of Mr. Bryant's authority. Being one of those who look upon an enlarged prostate, especially when congested with retention and surrounded by an enlarged venous plexus, as a structure to be treated with great respect, I think that there is an undoubted risk that perforating it may lead to septic phlebitis and abscess, and to suppuration in already impaired kidneys.

Mr. Bryant (*loc. supra cit.*) speaks very highly of puncture per rectum, and says that the objections raised against it are theoretical only—viz., abscess between the bladder and rectum, persistent fistulous opening, injury to the vesiculæ seminales or the peritonæum. I do not deny that these injuries are rare, but, as compared with supra-pubic puncture, the drawbacks which I have given above are practical and undoubted.

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* A useful form is made by Arnold. The angle at which the cannula bends down is very inconvenient in the early treatment, interfering as it does with the outflow of urine. It is only useful when the cannula is retained permanently, as it now can be worn conveniently under the dress. In other cases it is best removed. The cannula appears too long, but is not so for very fat abdominal walls. It is easily retained in place by tapes, and the urine runs off by tubing. To keep the cannula firm at first, I insert a silver suture in the puncture, cover this with iodoform and collodion, and pack some strips of dry gauze around. I generally give a little anæsthetic, but this is not needed. The skin puncture is alone painful.

† If an aspirator has been used, and it is desired to replace it with a catheter, a catgut bougie should be passed through the cannula, and, this being withdrawn, a small gum-elastic catheter, with an eye in its point, is passed over the bougie. Larger ones can soon be got in, passing them with terminal eyes over the smaller ones, or by means of a stylet (T. Smith).

‡ Thus, there are two specimens in Guy's Hospital Museum proving, by the double puncture present, that this is the case.

Operation.—If this method is employed, Mr. Cock's instruments should be made use of—viz., a very sharp and a blunt pilot-trocar, and a cannula with inner tubes to keep the cannula in position and to admit of its being closed. The patient being in lithotomy position and the rectum emptied, the surgeon feels for the distended bladder, behind the prostate, with his left index finger. This being kept *in situ*, he introduces the cannula and blunt pilot along the finger up to the point he intends to puncture. The pilot being withdrawn, the sharp trocar is introduced, and, when it is nearly up to the hilt in the cannula, it is depressed and then driven on in a direction upwards and forwards, as if aiming for the umbilicus. The trocar is then withdrawn, the inner tubes inserted, and the whole secured with tapes. The urine is best conveyed away by tubing.

iv. **Puncture through the Prostate.**—Mr. R. Harrison* has advocated this method, and published a most successful case in a patient, aged eighty-four, with prostatic retention. A special straight trocar was introduced in the middle line ¾ inch in front of the anus, and pushed steadily through the prostate into the bladder, the left index being retained in the rectum. The cannula was removed in nearly three months, natural micturition gradually returning. Atrophy of the enlarged prostate appeared to follow, and the symptoms were much relieved.

I cannot but think that this method runs the risk of septic phlebitis (*vide supra*). Another objection is that the patient is kept in bed. Micturition becomes natural much more quickly after supra-pubic puncture.

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* *Intern. Encycl. of Surg.*, vol. vi. p. 414.

CHAPTER XIV.

OPERATIONS ON THE URETHRA AND PENIS.

RUPTURED URETHRA.—EXTERNAL URETHROTOMY.—INTERNAL URETHROTOMY.—CHOICE OF OPERATION FOR RELIEF OF RETENTION.—EPISPADIAS. — HYPOSPADIAS.—CIRCUMCISION.—AMPUTATION OF PENIS.

RUPTURED URETHRA.

In a few cases the surgeon may succeed in passing a catheter into the bladder. If he do so in a case where there has been much bruising* of the perinæum and extravasation of blood, a median incision should still be made to allow of relief to tension and escape of clots as they break down, and so give good drainage. If this is not done, the probability is great that a little later, owing to damage of soft parts, tension of blood clot, and a little escape of urine by the side of the catheter, this step will be required, at a time when, from the presence of traumatic fever, and the condition of the extravasated blood, the occasion is less favourable. Again, though a catheter can be passed at the time, it by no means follows that when, owing to its being plugged, or from some other reason, it requires removal in a few days that a fresh one can be inserted. An incision will then have to be made, and, as already stated, under conditions less favourable.

When, as is usually the case, a catheter cannot be passed into the bladder, the patient is placed in lithotomy position, and the parts being shaved and cleansed, a grooved staff of as full size as the parts will admit is passed as far as it will go—*i.e.*, to the site of the rupture, it is then made to project in the perinæum, and the surgeon entering a straight sharp-pointed bistoury in the middle line at a point 1 inch to 1½ inch above the anus, pushes it on till it strikes the groove, and then cuts along this, both upwards and downwards, so as to expose freely the spot at which the urethra is ruptured. As the knife is brought out, the skin wound is enlarged till this is about 1½ inch long, the lower end being ½ inch above the anus.

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* Complete rupture of the urethra may co-exist with a mere contusion of the perinæum, especially if much tenderness is present.

With the finger clots are now turned out, and retractors being inserted deeply, the wound is sponged out thoroughly. A good deal of bleeding may now take place from some wounded vessel, hitherto closed by extravasated blood, or from the crus penis, detached on one side by the violence which ruptured the urethra, especially if there be a fractured pelvis. This hæmorrhage will yield to firm pressure or to forcipressure. The anterior end of the urethra is next readily found by the end of the staff, which projects through it, the finding of the deeper or vesical end, often difficult, will be facilitated by careful sponging, a mirror and reflected light, pressure above the pubes, and the use of fine probes or straight gum-elastic catheters. This end often projects as a small clot or bleeding-point, or other times it resembles a partly twisted artery.*

If it be found, a catheter of as large size as possible should always be introduced, if practicable, from the meatus, and then through the vesical end of the urethra into the bladder, guided by a finger in the wound, a Brodie's probe, or a Teale's gorget (Fig. 153). If this be found impracticable, a catheter should be passed into the bladder from the wound. One of these methods should always be made use of, if possible, as it enables the patient to be kept dry by tubing attached to the catheter.

But if no catheter can be got into the bladder, either along the penis or from the wound, the surgeon need not worry himself as long as a free exit has been given for the urine and extravasated blood. In these cases it is not unusual for the bladder to become somewhat distended during the first two or three days, owing to the urine not escaping with sufficient freedom, or to the closure of the vesical end of the urethra from swelling after the injury and the manipulations to find it, or from the patient, if a child, shrinking from passing his water. This difficulty will usually be met by hot flannels frequently applied to the abdomen, and a few doses of laudanum, but if it be evident that the urine does not escape with sufficient freedom, the surgeon must again examine the wound with the aid of an anæsthetic, clean out any fresh clots, and again try to find the vesical end of the urethra, aided now perhaps by a better light.

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* The farther back the tear, the greater, of course, the difficulty in finding the urethra.

If this fail, supra-pubic tapping or aspiration, or if the patient's condition be good, making a small supra-pubic opening into the bladder and thence passing a short curved staff into the perinæum and so finding the vesical end of the urethra (p. 948), must be resorted to.

Urethritis and cystitis are not uncommon in children. They are best met by, as soon as possible, leaving out the catheter for a while.

With regard to the advisability of trying to use sutures, it is always advisable, if possible, to draw the ends of the urethra together on the catheter, with a fine curved needle on a holder, and chromic gut or carbolized silk. But this will be often found a matter of great difficulty, and even impossible. When effected, it does not diminish the need of subsequent regular use of catheters.

EXTERNAL URETHROTOMY (Figs. 151–155).

This operation includes the different forms of perinæal section with or without a guide—viz., Syme's, Wheelhouse's, and Cock's operation.

By some, **external urethrotomy** is reserved for those cases such as Syme's, in which a staff can be passed through the stricture, and "**perinæal section**" for those in which no such help is available—*e.g.*, Mr. Cock's operation. As, however, these terms are readily confused by students, and as in Wheelhouse's operation a staff is used, though it cannot be passed through the stricture, I think it preferable to employ the term external urethrotomy, specifying which operation is meant by using the author's name—viz., Syme's external urethrotomy, &c.

Syme's External Urethrotomy.—Here the stricture is divided on a fine staff (*vide infra*) passed through it.

Indications.—This excellent operation is strongly indicated in (1) cases of stricture which do "not yield to dilatation, or, rather, continue to present symptoms after being dilated"—in other words, to contractile, irritable, and resilient strictures, in which dilatation is accompanied with much pain, or in which it is found that a No. 7 can perhaps be passed one day and only a No. 3 a day or two after; (2) cases in which rigors and constitutional disturbance follow any attempt at dilatation.

Operation.—The patient, being prepared by mild aperients and bland liquid diet for the operation, is brought under an anæsthetic, and while his legs hang over the end of the table, the surgeon introduces a Syme's staff. This has a narrow terminal portion, which passes through the stricture, a shoulder which rests upon the face of the stricture, and a wider, stouter part above the shoulder to make the instrument easier to find in the perinæum. The patient being placed, in a good light, in lithotomy position, and the parts cleansed and shaved, the surgeon makes an incision exactly in the median line down upon the staff, exposing the wider portion above the shoulder. When the surgeon is certain that this is laid bare, he runs the knife forwards along the groove, so as to divide the stricture completely. The staff is now withdrawn, and the rest of the treatment must vary somewhat. If the condition of the patient admits of it, a full-sized gum-elastic catheter should be passed from the meatus into the bladder, guided by a finger in the wound or in the rectum, or by a grooved director passed from the perinæum. If the irritability of the parts does not admit of this, a gum-elastic catheter must be inserted from the perinæum, cut short, and kept *in situ* with tapes, the urine running off, by tubing attached, into a basin containing carbolic acid; or Prof. Syme's curved perinæal catheter may be employed.

As soon as a catheter can be passed from the meatus, it should be kept in for two or three days, and changed, if needful, with an anæsthetic at first. As soon as possible, it should be passed twice a day, and the patient should be clearly told of the absolute necessity which exists of keeping up the good effects of the operation by passage of an instrument at regular intervals, and of occasionally reporting himself to his surgeon.

Wheelhouse's External Urethrotomy.—Here the stricture is first found by a staff passed down to it, and then divided on a fine probe-pointed director passed through it.

Mr. Wheelhouse (*Brit. Med. Journ.*, June 24, 1876) recommends his method as having "the advantage of greatly increased precision; it renders an operation, confessedly hitherto one of the most difficult in surgery, a comparatively easy one, and one which, in my hands and in those of my colleagues, has given results infinitely more favourable, with an immediate and ultimate effect upon our cases, than we had ever seen before its introduction."

Operation.—"The patient is placed in lithotomy position, with the pelvis a little elevated, so as to permit the light to fall well upon it, and into the wound to be made. The staff * (Fig. 151) is to be introduced with the groove looking toward the surface and brought gently into contact with the stricture. It should not be pressed much against the stricture, for fear of tearing the tissues of the urethra and causing it to leave the canal, which would mar the whole after-proceedings, which depend upon the urethra being opened *a quarter of an inch in front of the stricture.* Whilst an assistant holds the staff in this position, an incision is made into the perinæum, extending from opposite the point of reflection of the superficial fascia to the outer edge of the sphincter ani. The tissues of the perinæum are to be steadily divided until the urethra is reached. This is now to be opened, *in the groove* of the staff, *not upon its point*, so as certainly to secure ¼ inch of healthy tube immediately in front of the stricture. As soon as the urethra is opened, and the groove in the staff fully exposed, the edges of the healthy urethra are to be seized on each side with straight-bladed nibbed forceps and held apart. The staff is then to be gently withdrawn until the button-point appears in the wound. It is then to be turned round, so that the groove may look to the pubes and the button may be hooked on to the upper angle of the opened urethra, which is then held stretched open at three points thus (Fig. 152), and the operator looks into it immediately in front of the stricture. While thus held open, a probe-pointed director* is inserted into the urethra, and the operator, if he cannot see the opening of the stricture, which is often possible, generally succeeds in very quickly finding it, and passes the point onwards *through* the stricture towards the bladder. The stricture is sometimes hidden amongst a crop of granulations or warty growths, in the midst of which the probe-point easily finds the true passage. The director having been passed into the bladder (its entrance into which is clearly demonstrated by the freedom of its movements), its groove is turned downwards, the whole length of the stricture is carefully and deliberately divided on its under surface, and the passage is thus cleared. The director is still held in the same position, and a straight probe-pointed bistoury

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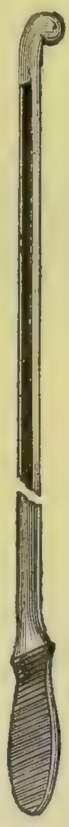
* This is fully grooved through the greater part, but not through the whole of

FIG. 151.



(Wheelhouse.)

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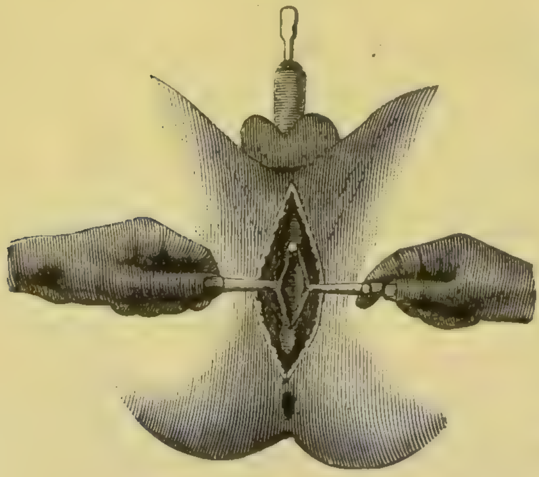
its extent, the last half inch of the groove being "stopped" and terminating in a round button-like end.

* Or a common blunt-pointed probe may be used. Occasionally a bougie (No. 2 or 3) is useful.

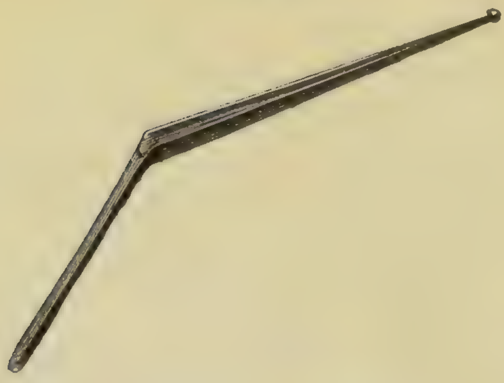
is run along the groove to ensure complete division of all bands or other obstructions. These being thoroughly cleared, the old difficulty of directing the point of a catheter through the divided stricture and onwards into the bladder is to be overcome. To effect this, the point of a probe-gorget (Fig. 153) is introduced into the groove in the director, and, guided by it, is passed onwards into the bladder dilating the divided stricture, and forming a metallic floor, along which the point of the catheter cannot fail to pass securely into the bladder. The entry of the gorget into the latter viscus is signalized by an immediate gush of urine along it. A silver catheter (No. 10 or 11) is now passed from the meatus down into the wound, is made to pass once or twice through the divided urethra, where it can be seen in the wound, to render certain the fact that no obstructing bands have been left undivided, and is then, guided by the probe-gorget, passed easily and certainly along the posterior part of the urethra into the bladder (Fig. 154). The gorget is now withdrawn, the catheter fastened in the urethra and allowed to remain for three or four days, an elastic tube conveying the urine away. After three or four days the catheter is removed, and is then passed daily, or every second or third day, according to circumstances,

FIG. 152.



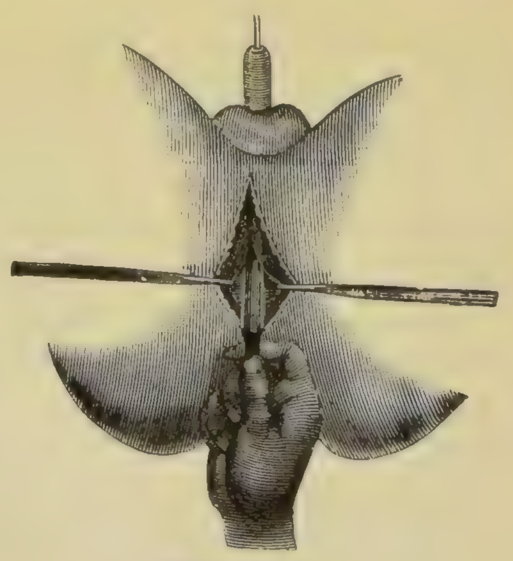
(Wheelhouse.)

FIG. 153.



Teale's probe-gorget.

FIG. 154.



(Wheelhouse.)

until the wound in the perinæum is healed; and after the parts have become consolidated, it requires, of course, to be passed still, from time to time, to prevent recontraction."*

This will be found a most effectual operation, but in many cases the hitting off of the mouth of the stricture is a less simple matter than would be gathered from Mr. Wheelhouse's account. This is especially the case when the parts are engorged and softened, as the free oozing which is met with under these conditions may be most difficult to arrest even with firmly applied sponges on holders, the slightest trickling of blood being sufficient to obscure the orifice of the stricture. A false passage at the site of the stricture may complicate matters very much, and a stricture in the penile portion of the urethra may prevent the passage of the staff altogether. A good light, gentleness and patience are at all times requisite.

Cock's Operation.—An external urethrotomy, which opens the urethra behind the stricture, and without a guide (Fig. 957). The following, in the words of its deviser, are the *advantages* of this operation so well known to Guy's men (*Guy's Hosp. Reports*, 1866, vol. xii. p. 267): "The bladder is reached without any unnecessary mutilation of the perinæum. The communication is effected in nearly a straight line from the exterior to the cavity of the viscus, so that the cannula, which is inserted and retained, can be removed whenever necessary, and can be easily replaced. The functions of the entire urethra are suspended, and may be kept in abeyance for an unlimited period. The urine no longer finds its way abnormally through the stricture and sinuses of the perinæum. The tissues are no longer subjected to constant irritation from infiltration. The constitutional symptoms are relieved, and time and opportunity are given for the removal by absorption of those adventitious products which obstructed the urethra, indurated the perinæum, and rendered the introduction of an instrument impossible. The pressure on the kidneys is removed, and, if expedient, the bladder may be readily washed out, until its lining membrane assumes a healthy character. The strictured and damaged portion of the urethra being no longer subjected to the constant pressure of urine from behind, may probably so far recover itself as to allow of restoration by the ordinary means of dilatation; or, should the canal have become permanently obliterated, the patient still retains the means of emptying his bladder through the artificial opening without difficulty or distress, and at very moderate inconvenience to himself."

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* The wound should be syringed occasionally during the operation with a dilute solution of mercury perchloride, and a little iodoform dusted in at the close. If any bleeding is going on, the wound should be plugged around the catheter with strips of iodoform or sal-alembroth gauze, or Spencer Wells's forceps left *in situ*.

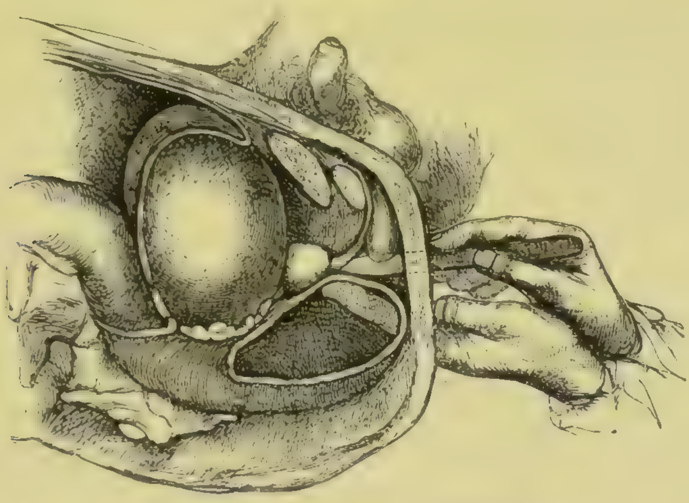
The following are *the cases to which the operation is well suited*:—Where the stricture has existed for a number of years; where the urethra has become permanently obstructed or destroyed by the constant pressure of urine from behind, and by reiterated attempts, generally fruitless, to introduce an instrument; where extravasation into the perinæum has again and again taken place, causing repeated abscesses and their consequences, the formation of urinary sinuses and fistulæ, until the normal textures of the perinæum become obliterated, and are replaced by an indurated, gristly structure; where the bladder has become thickened and contracted by the constant action of its muscular coat until little or no cavity is left, and where the urine is constantly distilling by drops, either through the urethra or through one or several fistulous openings, which dot the surface of the perinæum, penetrate through the indurated scrotum, and even find their way to the nates below, and the region of the pubes above. If unrelieved, these cases invariably terminate fatally.

The keystone of the whole proceeding is the fact that, "however complicated may be the derangement of the perinæum, and however extensive the obstruction of the urethra, one portion of the canal behind the stricture is always healthy, often dilated, and accessible to the knife of the surgeon. I mean that portion of the urethra which emerges from the apex of the prostate—a part which is never the subject of stricture, and whose exact anatomical position may be brought under the recognition of the finger of the operator."

Operation.—"The patient is to be placed in the usual position for lithotomy; and it is of the utmost importance that the body and pelvis should be straight, so that the median line may be accurately preserved. The left forefinger of the operator is then introduced into the rectum, the bearings of the prostate are next examined and ascertained, and the tip of the finger is lodged at the apex of the gland. The knife is then plunged steadily, but boldly, into the median line of the perinæum, and carried on in a direction towards the tip of the left forefinger, which lies in the rectum. At the same time, by an upward and downward movement, the vertical incision may be carried in the median line to any extent that is considered desirable. The lower extremity of the wound should come to within ½ inch of the anus.

"The knife should never be withdrawn in its progress towards the apex of the prostate, but its onward course must be steadily maintained, until its point can be felt in close proximity to the tip of the left forefinger. When the operator has fully assured himself as to the relative position of his finger, the apex of the prostate, and the point of his knife, the latter is to be advanced with a section somewhat obliquely, either to the right or the left, and it can hardly fail to pierce the urethra. If, in this step of the operation, the anterior extremity of the prostate should be somewhat incised, it is a matter of no consequence.

FIG. 155.



Mr. Cock's operation. (Bryant.)

"In this operation it is of the utmost importance that the knife be not removed from the wound, and that no deviation be made from its original direction until the object is accomplished. If the knife be prematurely removed, it will probably, when reinserted, make a fresh incision and complicate the desired result. It will be seen that the wound, when completed, represents a triangle; the base being the external vertical incision through the perinæum, while the apex, and constantly the point of the knife, impinges on the prostate. This shape of the wound facilitates the next step of the operation.

"The knife is now withdrawn, but the left forefinger is still retained in the rectum. The probe-pointed director is carried through the wound, and, guided by the left forefinger, enters the urethra, and is passed into the bladder. A No. 12 gum-elastic catheter, straightened on its stylet, is slid along the director, the stylet then removed, the catheter cut short, and secured in position with tapes."

While most fully alive to the excellence of this operation, both as to speediness of relief and the perfect rest it gives to damaged parts, I should like to point out to those who are only likely to perform it occasionally, (*a*) that it is not such an easy operation as it appears; (*b*) that it is a severer operation than the size of the wound would suggest. Hæmorrhage is not very uncommon from the engorged condition of the parts, and a low form of septic phlebitis is not very infrequent after the operation. For these reasons I would restrict it to the cases mentioned at p. 962.

Complications and Causes of Failure after External Urethrotomy.

1. Hæmorrhage (p. 961). 2. Rigors. These should be met by warmth, leaving out the catheter or substituting a softer one; plenty of diluent drinks, washing out the bladder with diluted Thompson's fluid (p. 918), Dover's powders, or small injections of morphia, if the condition of the kidney admits of these. Five or ten grains of quinine may be given in milk every two or three hours, if it does not excite vomiting. 3. Septic troubles—*e.g.*, septic phlebitis. 4. Pelvic cellulitis. 5. Persistence of a fistulous opening in the perinæum. 6. Recurrence of the contraction.

CHOICE OF AN OPERATION FOR THE RELIEF OF STRICTURE-RETENTION.*

It will have been gathered from the remarks at p. 951 that supra-pubic aspiration † may be used in very urgent cases, and may be repeated safely once. For the large majority of cases of retention due to stricture, especially where the patient is under forty-five, and a few days' rest will ensure the passage of a catheter, I believe that supra-pubic tapping of the bladder will be the safest and simplest operation. This will be followed in four or five days by the passage of a catheter, aided by an anæsthetic, and guided by a little judicious force, combined with a knowledge of anatomy. Wheelhouse's operation is very highly spoken of by the Leeds surgeons. A good light and especial instruments are essential. The cases to which Mr. Cock's excellent operation should be limited have been already pointed out (p. 962).

INTERNAL URETHROTOMY.

Indications.—Before specifying these, I would say that, with regard to the question between external and internal urethrotomy, it is chiefly a matter of personal experience. In other words, surgeons who practise frequently some such operation as that of Prof. Syme, and I confess I am of the number, will probably have as good results as those who resort to internal urethrotomy. As it is a clean division of the entire stricture which is required, this can be effected most readily, and with less practice, and with simpler instruments, by external urethrotomy. But it must be remembered that, after all, it is not so much the division of the stricture, whether from without or within, which will be curative, as the amount of perseverance which the patient shows afterwards. Again, at the commencement of internal urethrotomy, each stricture must be dilated sufficiently to admit, in the case of an instrument cutting from without inwards, a split sound equivalent to No. 2 English, while in instruments cutting in the opposite direction, the bulb is as large as No. 4 or 5. This being so, the cases must be very few in which the surgeon does not find it possible, and in which the patient does not prefer, to complete the case by dilatation.

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* The supra-pubic tapping has been already recommended for retention due to an enlarged prostate.

† In the absence of an aspirator, an ordinary hydrocele trocar may be safely used.

Amongst these few cases are—1. Strictures localized and of the nature of annular, which (a) contract rapidly after dilatation, or (β) in which rigors persistently follow attempts at dilatation. 2. Non-dilatable strictures—*e.g.*, some traumatic ones. 3. Penile strictures. These are very elastic and shrink quickly after dilatation, and incision of these strictures seldom causes serious constitutional disturbance. 4. In some cases where time is an object. Thus, in young subjects whose disease has not existed long enough to alter the condition of the kidneys, cutting may be admissible for a stricture that should be simply dilated in an older patient whose kidneys have undergone degeneration (Berkeley Hill, *Dict. of Surg.*, vol. ii. p. 727). 5. According to some (Berkeley Hill, *loc. supra cit.*), urethrotomy affords a longer interval of freedom from contraction than does any other plan of widening a stricture.

Contra-indications.

1. Strictures not localized and ring-like, but extending over a considerable surface. 2. A "stricture" in which the difficulty is mainly due to congestion,* though this is scarcely a stricture at all. 3. A stricture accompanied by urethritis.

I have endeavoured to point out fairly the indications for internal urethrotomy. I suspect that this is one of those operations of which an increasingly frequent use is liable to lead to something very like abuse. But, however this may be, I should like to point out first a fallacy as it seems to me. Thus, Sir H. Thompson (*Dis. of Urin. Organs*, p. 40) speaks of a urethrotome as "nothing more than a little knife with a long blade . . . . used precisely as we use a scalpel anywhere else. Just as we should use a small knife in tenotomy, without the sense of vision, where it is not necessary, but guided by the sense of touch, so do I advise you to act in urethrotomy." No doubt this comparison is correct as far as it goes, but its very simplicity is misleading. There can be no real comparison, I maintain, between division of a tendon, which can always be practically made subcutaneous, and that of a stricture, perhaps 4 inches from the surface, surrounded by vascular tissue, incision of which may easily lead to hæmorrhage or septic trouble, an incision which cannot from the subsequent flow of urine be completed aseptically, and which implicates other parts in such intimate sympathy with that operated on—*e.g.*, the kidneys.

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* As bearing upon the allied condition of "spasm," the above surgeon (*Brit. Med. Journ.*, 1879, vol. ii. p. 856) states that if an apparently narrow bulbo-membranous and a penile stricture co-exist, on the latter being properly divided, the former will disappear, having been due to reflex muscular contraction.

Again, I would point out that internal urethrotomy is not the simple affair that it is sometimes represented to be. I would refer my readers to the experience of one whose name is associated with this operation. Mr. Berkeley Hill (*Lancet*, April 8, 1876, p. 524) speaks thus of a trial which he gave to the method of treating early stricture by Otis's operation of internal urethrotomy:—

"All the cases operated on were those of long-standing gleets, with contraction in one or more parts of the spongy urethra, and had undergone multifarious treatment. The number of patients is sixteen—fifteen of my own, and one of Dr. Otis's. In five cases the gleet stopped after the operation, and the patient was at the last report—taken in none less than three weeks, in most some months, after the operation—able to pass a bougie of the estimated size of the urethra. In short, they may be claimed as cures. But of these five the operation was serious to two; one had free bleeding for three days, the other three attacks of rigors. Of the remaining eleven, among whom Dr. Otis's own operation must be included, the gleet persisted in all; in several the urethra shrank again to its size before the operation, and in some very serious complications ensued. In four bleeding lasted several days, and in one was alarming. Three patients had rigors; in two the shivering was unimportant, being that which follows the first transit of urine along the incised urethra in certain individuals, but is not repeated or attended by further consequences. In the third patient the rigors preceded abscess in the buttock. One patient had orchitis. Thus, in seven the operation might fairly be termed a trifle, causing no pain nor any after-fever, but in five only was the operation successful."

Complications.—(1) Hæmorrhage. If severe this may be met by pressure on the perinæum, with a pad or a stick in the bed so that the patient may keep up the compression himself. (2) Perinæal abscess. (3) Sloughing and perinæal fistula. These are very rare. (4) Extravasation. (5) Septicæmia. (6) Epididymitis. The first five of these are usually due to cutting too deeply, or to the patient not being sufficiently prepared or unfit for the operation. The last is usually brought about by injudicious haste in the use of bougies.

The essentials of a good urethrotome are: (1) a guide through the stricture into the bladder, usually in the form of a filiform guide-bougie, or of a curved terminal portion of the urethrotome, sufficiently fine to pass through the narrowest stricture; (2) a cutting edge which, at first shielded, can be protruded by the surgeon as exactly as he desires; (3) some means of steadying the mobile stricture fibres as they are divided.

Two Chief Modes of Internal Urethrotomy.—The stricture may be divided—(*a*) **From without inwards**—*i.e.*, **towards the bladder.** (*b*) **From within outwards, away from the bladder.** A short account of the chief instruments will be given, and the two methods briefly contrasted.

a. **Those Cutting from Without Inwards.**—By this means narrower strictures can be divided than in the other method, in which the instruments used are usually based on Civiale's pattern, in which the bulbous end carries the knife (p. 965).

Most of the urethrotomes which cut from without inwards are modifications of Maisonneuve's pattern. A fine hollow staff being guided through the stricture by a filiform bougie, along the hollow staff a stylet carrying a triangular shield or wedge is run; this pushed against the stricture serves to steady it, while it is divided by a knife concealed in the wedge or shield.

One of the best known of the recent instruments on this pattern is Mr. B. Hill's. It consists of a narrow split sound, No. 2 English, which can be guided through narrow tortuous strictures by being attached to a filiform bougie, previously passed into the bladder.* Secondly, a wedge runs along dovetail grooves between the halves of the split sound. In this wedge is concealed a knife that can be protruded between the halves of the split sound, when the stricture-tissue prevents their separation sufficiently to allow the wedge to pass on. The wedge,* pushed up to the situation of the stricture, in separating the split sound tightens and steadies the stricture thoroughly, while the knife divides it to the width required by the wedge to pass along.† If a wedge be chosen to expand the urethra to its full natural capacity, the cut will not pass beyond the stricture into the vascular erectile tissue external to it. The knife can be applied to the upper or under surface of the stricture as preferred.

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* If it is doubtful whether the guide has reached the bladder, Mr. Hill advises

Harrison's Urethrotome.—This also cuts from without inwards, but on a different plan; this instrument ending in a catheter-like extremity and thus dispensing with the filiform guide-bougie. Such a pattern will be preferred by many surgeons, especially by those who use fine metallic instruments in dilating strictures. The anterior part of Mr. Harrison's urethrotome is sufficiently small to pass into the narrowest strictures, behind this is a broad portion equal to a No 10 bougie, and terminating anteriorly in an abrupt shoulder. Within this broad portion is contained a lancet-shaped knife, which is made to project by a spring in the handle and to run along a slit in the narrow part of the instrument. The extent to which the blade can be projected is regulated by a screw. When the instrument is passed down the urethra, the position of the stricture is indicated by the broad shoulder, against which it is pressed firmly, as with Syme's staff. The position of the stricture being thus ascertained and fixed by the shoulder, the knife is projected and the stricture divided. The knife being withdrawn, if the stricture has been completely divided, the broad shoulder passes on readily into the bladder. The stricture is, by this instrument, divided above and below. Dilatation is maintained by the passage of laterally oval bougies.

B. **Those Cutting from Within Outwards.**—A good representative of these instruments is Sir H. Thompson's modification of Civiale's urethrotome. This has a bulbous extremity, from which the blade is protruded. The stricture being sufficiently dilated to admit a No. 4 or 5 bougie, the bulb (which forms a useful sound)

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to screw on a No. ½ flexible catheter to the guide, and to push the whole onwards till the catheter has passed 8 inches inwards. A small exhausting syringe is then applied to the catheter, and a few drops of urine drawn through it.

* The meatus must be divided, if too small to admit the wedge.

† After the first cut, the knife is withdrawn within the wedge, and only protruded when a tight band opposes the free passage of the wedge.

is carried about $\frac{1}{3}$ inch beyond the stricture, the knife projected, and the incision made by drawing it slowly and firmly outwards —to the distance of $\frac{1}{2}$ to 2 inches—generally along the floor of the urethra, so as to incise the stricture freely. A metallic bougie is then passed, and if at any point it is held closely, there is still almost certainly some spot which needs touching with the blade.

After-treatment.—This varies very much. Some surgeons—*e.g.*, Sir H. Thompson and Mr. Harrison—pass at once and tie in a full-sized catheter for twenty-four or forty-eight hours, passing after this a full-sized instrument at intervals. Others—*e.g.*, Mr. B. Hill—draw off the urine with a full-sized catheter, after division of the stricture, but tie none in. The patient is ordered not to micturate for eight hours if possible. By this time the incision is protected by clot and plastic lymph, and when the bladder must be emptied, the patient passes water in a hot bath, pain, spasm, and risk of tearing open the wound being thus avoided. The patient is kept in bed for ten days, and about the eighth day a full-sized bougie is passed, this period of rest being insisted upon to avoid pain, bleeding, and suppuration.

Comparison of the two Methods of Internal Urethrotomy.—With the instruments which cut from without inwards, and guided by a filiform bougie, narrower strictures can be attacked than by the bulbous-ended urethrotome, cutting in the reverse direction. These latter have been recommended as having the advantage of steadying the fibres to be cut by their pulling forwards the parts which attach the urethra to the pelvis, as the bulbous end of the instrument is drawn out. The stricture is thus pulled on by the instrument until the divided stricture gives free passage to the bulbous shield and the knife protruded from it. Mr. B. Hill, however, considers that "reliance cannot be placed on the simple straining of these attachments ensuring perfect division of the stricture tissue. A Civiale's or any other urethrotome which cuts from within outwards is very apt to wriggle its way through a stricture, only scoring it, but not perfectly severing its fibres, and to meet this difficulty the knife is often carried more deeply than is necessary." Mr. Hill further believes that by cutting from without inwards there is less risk "of making an incision through a thin layer of fibrous tissue into erectile tissue, in the belief that a thick layer of fibrous tissue exists," and thus of causing free hæmorrhage.

While myself usually practising what, on the whole, I believe to be preferable, continuous dilatation aided, if need be, by external urethrotomy such as Prof. Syme's operation, I have, I trust, here fairly dealt with internal urethrotomy. Before leaving this matter I should like to allude to the question of *time.* Internal urethrotomy no doubt saves time and trouble also, but it must not be thought that the saving is such a very large one. Thus, with regard to time, Mr. B. Hill writes:[*] "It is indispensable that the patient lie in bed continuously for at least ten days, and keep his room for fourteen days." Subsequent regular passage of a bougie is as needful after internal urethrotomy as any other mode of treating stricture.

ECTOPIA VESICÆ AND EPISPADIAS.

Owing to the misery which this condition entails, the surgeon may always be ready to operate, in the hope, at least, of making the wearing of a urinal easy and efficient, if he cannot secure the formation of a sufficient cavity to retain fluid : at the same time, from the contraction resulting from his operation, a partial or complete cure of the herniæ, which not unfrequently accompany this malformation, may be secured.

Age.—The cure of the ectopia may be commenced after the child is four or five, and should be completed, if possible, by puberty. In this case the epispadias may be taken in hand and completed before adolescence, when the growth of hairs and sexual desires will interfere much with the union of the flaps.

Unfavourable Conditions.[†]

1. Large size of the ectopia, with much bleeding and some purulent discharge from the surface. 2. A sickly condition of the patient, pointing to poor powers of repair, and a waddling gait to wide separation of the pubes. 3. Tendency to cough. This increases the protrusion. 4. Presence of large herniæ. 5. Secondary dilatation of the ureters and pelves of the kidneys, with degeneration of these viscera.[‡] 6. Obstinate eczematous rawness. 7. Small size of the scrotum. This is rare.

Preparatory Treatment.—If the patient has passed puberty, and the hair is at all abundant, depilation should be practised, and nitric acid applied at intervals to the groups of hair-follicles.

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[*] *Dict. of Surg.*, vol. ii. p. 729. See also the Lectures, alike candid and helpful in detail, by the same surgeon (*Brit. Med. Journ.*, 1879, vol. ii. pp. 763, *et seq.*).

[†] For full information on all these matters Mr. J. Wood's articles (*Dict. of Surg.*, vol. i. p. 425, and *Med.-Chir. Trans.*, vol. lii. p. 85) should be consulted.

[‡] Mr. Wood (*loc. supra cit.*) shows that sometimes the above complication may be recognized by the presence of more albuminuria than is accounted for by the amount of cystitis. In other cases, no such signs are present. Out of forty cases, a fatal result, chiefly from this cause and undetected, followed in four.

It may be well also to try and diminish the size of the ectopia by the means adopted by Mr. Greig Smith, who, for some weeks previous to operation, kept the patient on his back, and the exposed mucous membrane shielded with green protective coated with dextrine, covering this over with boracic lint; by this means, in one case, the mucous membrane not only became less angry, but its upper half, almost as low as the ureters, became covered with epidermis almost as white as the surrounding skin.*

Operation.—An anæsthetic being given, a median flap† is raised from the abdominal wall above the exposed bladder. Its shape resembles that of the wooden portion of a fire-bellows, its length is rather greater than the distance between the root of the penis and the upper margin of the exposed bladder, while its root must be sufficiently broad to ensure a sufficient blood-supply. In raising it, care must be taken not to cut it too thin, and, at the same time, not to go too deeply with the point of the knife, as the tissues here are extremely thin, and the flat, tense, expanded linea alba beneath is often very thin, and thus the peritonæal cavity may easily be opened.

The two groin flaps are next made, of rounded-oval shape, with broad pedicles, the outer boundary of which is sufficiently carried out on to the thigh, and then on to the root of the scrotum, to ensure its containing the superficial epigastric and the external pudic arteries. The inner margins of these flaps join those for the central flap at about its centre, and are then continued down along the side of the urethral groove for about half its length.

While these flaps must be cut as thick as possible, care must be taken to avoid any subsequent herniæ, and they must be sufficiently detached to meet for their whole length without tension in the middle line. In raising them they must be handled as carefully as possible, whether with fingers or with bluntly serrated forceps, so as in no way to impair their vitality. All bleeding being stopped, the flaps being washed with boracic-acid lotion, and their surfaces allowed to become glazed,‡ the umbilical flap is first taken and folded down, with its skin surface towards the bladder, evenly and without tension. It is then stitched to the cut edge at the root of the penis.

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* In another case, also successfully operated on, no preliminary treatment was of any avail in diminishing the size of the ectopia.

† The shape and arrangement of the flaps is excellently shown in pl. ii. figs. 1 and 2, accompanying Mr. Wood's paper (*Med.-Chir. Trans.*, vol. lii.). Some drawings of the different flaps in a paper by Mr. Mayo Robson (*Brit. Med. Journ.*, 1885, vol. i. p. 222) will also be found useful.

‡ Spencer Wells's forceps should be left on for five or ten minutes to any

The groin flaps are then drawn inwards, placed with their raw surfaces upon the raw surface of the umbilical flap, and carefully stitched together. The sutures should be many and mixed, of wire, carbolized silk, fishing-gut, and horsehair. Wire has the advantage of being non-irritating and of keeping sweet in a wound which cannot be kept aseptic. The sutures should be left in for a fortnight, and, in the case of children, it may be well to give an anæsthetic to take them out.

The raw surface from which the central flap was taken is then closed, as far as possible, with long hare-lip pins and twisted sutures, but the object here must be rather to take tension off the flaps than to completely close this wound.

The parts are then painted with collodion and iodoform, and sal-alembroth gauze applied, and the buttocks and hips smeared with eucalyptus and vaseline. If any redness appear, wet boracic-acid lint dressings should be made use of.

After-treatment.—The patient must be kept partly sitting, the shoulders being well propped up and the knees flexed; a bandage passed from the knees around the shoulders will facilitate this. Any sudden straightening of himself by the patient is fatal to a good result. For the first few days small opiates or injections of morphia will be required.

HYPOSPADIAS.

I have only space to allude to some practical points which may be useful to a surgeon when consulted about the advisability of an operation.

Varieties.—These are three, viz.:—1. Glandular.—The opening is here merely further back than usual, the frænum is absent, the glans broad, flattened, somewhat recurved, and the prepuce, often hood-like, always in a condition of partial paraphimosis. 2. Penile.—Here the urethra is especially liable to open at one of the three following sites:—(*a*) Just behind the glans; (*b*) at the middle of the penis; (*c*) at the junction of the penis and scrotum. 3. Scrotal.*—Here the cleft on which the urethra

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bleeding points, and all ligatures, even of fine chromic gut, dispensed with, if possible. Oozing will yield to firm sponge-pressure.

* The above is sometimes divided into two, scrotal and perinæo-scrotal.

opens may be either at the junction of the penis and scrotum, or involve the scrotum and perinæum, the former being called peno-scrotal, and the latter perinæo-scrotal.

When an operation is under consideration, with a view of rendering micturition and coitus normal, the surgeon must take into due consideration—(α) the degree of the deformity; (β) whether the penis is fairly developed; (γ) whether it is much tied down; (δ) whether the testicles are present and descended; (ϵ) how far the patient's condition is made miserable by rawness and eczema due to impeded micturition, and by impeded coitus; and how far there are reasonable hopes of restoring these.

Operation.—I shall describe here that of M. Duplay, of the Lariboisière Hospital. He divides the restoration into the following three stages, which require, in order to be successful, much time and patience on the part of both surgeon and patient:—

i. *Straightening the penis and formation of a meatus*; ii. *Formation of a canal from the meatus to the hypospadiac opening*; iii. *Junction of the old and new canal.*

i. *Straightening the Penis.*—In the penile, peno-, and perinæo-scrotal varieties, the penis, often short, is recurved,* especially during erection, by a band consisting partly of a muco-cutaneous ridge, corresponding to the absent urethra, and reaching from the hypospadiac orifice to the glans. M. Bouisson seems to have first pointed out the importance of dividing this, which he did subcutaneously (p. 974). M. Duplay recommends division by an open wound, carrying the incision as deeply as needful, and states that the corpora cavernosa may be incised to a very considerable depth, if needful to secure this end.

At the same time the above-named surgeon forms a meatus. This is done by paring the two lips of the depression which represents the meatus, and uniting these over a bit of catheter. If the depression be very shallow, an incision upward into the glans-tissue, or two lateral ones, may be needed before it is possible to insert a catheter, and to apply sutures round it.

ii. *Formation of a New Urethra.*†—The penis being held up, two incisions are made a little outside the lateral margins of the mucous surface corresponding to the deficient urethra, and reaching from the glans to the hypospadiac orifice. By making two transverse incisions at either end, two narrow quadrilateral flaps* are dissected up towards the middle line until, with their mucous surfaces turned inwards and their raw surfaces outwards, they meet without tension over, and thus shut in a catheter passed from the previously restored meatus to the hypospadiac orifice. These flaps are now united with sutures, partly of fine chromic gut and partly of fine carbolized silk, cut quite short. From the sides of the penis two similar flaps are dissected up from within outwards, till they can be sufficiently drawn inwards without tension to cover over the raw surfaces of the internal flaps. They are then carefully united in the middle line. I much prefer horsehair and fishing-gut sutures here, well soaked previously in warm carbolic acid.

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* This recurving is also in part due to thickening and shortening of the capsule of the corpora cavernosa, and even of the septum.

† Several months, at least five or six, must elapse before the surgeon is certain that no recurving will occur. This disappears very gradually.

M. Duplay uses silver wire, and to prevent the sutures cutting through during erections, &c., he passes them through small leaden perforated tubes, fixing the sutures with shot. Whichever method is used, the sutures should be fine, and put in sufficiently close to distribute the tension, but not too numerously, or tied too tightly, which will cause sloughing.

iii. *Joining the Old and New Urethra.*—As soon as the new urethra is thoroughly established, quite closed, and shows no sign of contraction, this last stage may be undertaken. The edges of the posterior end of the new urethra and those of the remaining orifice having been freely vivified, and a catheter passed from the meatus into the bladder, the opening is closed over it by sutures as in stage ii. A catheter—one of Jaques' pattern is least painful—should be kept in the bladder if possible, till all is water-tight.

EPISPADIAS.

I am unable to find space for any really full account of the different attempts to cure this rare condition. For some points of practical importance I would refer my readers to the remarks on hypospadias (p. 972).

Any attempt at curing epispadias should be divided into three stages, thus :—

i. *Straightening the Penis.*—While the penis is short, recurved, so as to lie in contact with the abdominal wall, it is no use trying to complete the defective urethra. Attempts should be made to straighten the penis by dividing it subcutaneously close to the pubes, each corpus cavernosum being cut separately. In the only case in which I practised this, in a patient aged seventeen, the hæmorrhage was easily controlled by dry gauze and light pressure, but very sharp tenotomes must be employed, as the erectile tissue offers much less resistance than a tendon. Each corpus cavernosum should be divided completely, and as cleanly as possible. The penis must, for some time, be kept fastened down, improvement in its position takes place gradually, together with increase in its length, this being, eventually, more marked the earlier the operation is performed.

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* The formation of these flaps is well shown in Fig. 1349 in M. Duplay's article (*Intern. Encycl. of Surg.*, vol. vi. p. 500).

ii. *Completion of Deficient Urethra from the Meatus to the Epispadiac Opening.*—The simplest way of effecting this is by the method of Thiersch and Duplay, much as in hypospadias, to the account of which I would refer my readers. Two narrow quadrilateral flaps extending from the meatus to the epispadiac orifice are marked out and dissected up from without inwards on either side of the open urethra, both being left attached in the middle line. These turned with their muco-cutaneous surface inwards, over a small Jaques' catheter, to form the new urethra, and their raw surfaces outwards, are united in the middle line with numerous points of sutures cut short and buried (p. 974). Thin flaps dissected up from within outwards from off the dorsum and sides of the penis are then drawn inwards, raw surfaces being thus opposed to raw surfaces, and kept *in situ* by numerous points of sutures.

iii. *Junction of the Old and New Canal by Closure of the Epispadiac Opening.*—This is effected by freely refreshing the surrounding parts and suturing them carefully. Before the union is complete, several operations may be required, both for this condition and hypospadias.

CIRCUMCISION.

Trivial as this operation seems, it is so important, especially in adults, to secure speedy healing, that it will be briefly alluded to here.

Indications.—This operation is still not practised often enough, especially amongst poorer patients, amongst whom many practitioners still treat phimosis as a matter of but little importance. Hospital surgeons have, only too often, opportunities of seeing the following results follow from the above course:—(*a*) Balanitis and adhesions. (*b*) Paraphimosis, from the forcible retraction of a phimosed prepuce. (*c*) From the impediment to micturition, urethral and vesical irritation, and even cystitis may be set up, simulating the symptoms of stone. (*d*) Hernia and prolapsus recti. (*e*) The sexual feelings too early induced, and bad habits.* (*f*) Impediments to intercourse. (*g*) Intensified gonorrhœa, chancres, &c. (*h*) Epithelioma.

Operation.—This may be performed in many different ways, but the following points must be remembered in every case :—(1) To remove enough of the mucous layer of the prepuce. If this be not done, some tension on the glans remains, and this leads, especially in adults, to troublesome erections which interfere very much with the process of healing ; later on, some degree of phimosis is certain to persist. (2) Not to leave too much tissue about the frænum. Mr. Howse (*Guy's Hosp. Reports*, 1873, p. 239) has drawn attention to the fact that the cellular tissue at this spot is loose, and that the presence of the frænal artery makes probable the gathering of blood and inflammatory effusion at this spot. In children this is a matter of less importance, but in adults it may lead to the formation of a tediously persistent lump, interfering with the function of the organ. (3) Not to remove too much of the prepuce. Thus, it is always well, in adults especially, to leave enough to cover easily the sensitive papillæ with which the corona abounds. Again, in the diminutive organ of infants, it is very easy to remove so much as to nearly flay the body of the organ.

The following is a very simple mode of operating :—The prepuce having been separated as much as possible from the glans with the finger and thumb, or a stout probe, a pair of dressing-forceps is lightly placed on the penis at a level with the corona ; the glans being next allowed to slip back, the forceps are closed, and all the prepuce in front of the instrument is cut off with a sharp scalpel used with a rapid sawing movement. The blades being at once removed, the mucous membrane is then slit up with a director and scissors or a sharp-pointed bistoury,† this incision running up to, but not beyond, the corona. The mucous membrane, if still adherent, must be peeled in two flaps from off the glans, this detachment being effected by the finger and thumb, or by a stout probe swept round. The cut edges of the prepuce are then rounded off with scissors, which follow the curve of the glans as far as the frænum, the prepuce being left attached here. Enough prepuce should be left to cover over the corona-papillæ, and to admit of easy stitching. Chromic gut and horsehair make the best sutures. Very fine needles should be used, and the sutures passed quickly through skin and mucous membrane with a stabbing movement, and without bruising the edges with forceps. In passing the sutures any bleeding-points must be transfixed, and the abundant cellular tissue* kept in its place with the point of a probe. The frænum is now attended to, the prepuce which is still attached here being cut away carefully by **V**-shaped cuts, pointing forwards, and leaving just enough flaps to carry the sutures and no more. The frænal artery can usually be secured by transfixing it with one of the sutures; if not, it is readily tied with a fine chromic-gut ligature.

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* Prof. Sayre (*Orthopædic Surgery*, p. 14) describes cases in which paralysis of certain groups of muscles, leading to talipes and other deformities, followed on early sexual excitement, due to phimosis. See also the case recorded by Mr. Hilton (*Rest and Pain*, p. 276).

† It is well at this stage to make tension on the loose prepuce with two pairs of dissecting forceps, and thus secure a clean section.

I much prefer interrupted sutures of the above given materials for circumcision; a continuous suture often gives good results in healthy subjects, but the former have the great advantage that one or two can be removed without interfering with the rest.

For adults, one of the following dressings will be found the best. When the parts are at all swollen, or where erections are likely to be troublesome, I use boracic-acid dressings, two layers of boracic-acid lint wrung out of a saturated solution of the lotion. The deeper layer has a hole cut to allow of micturition and is only removed by the surgeon, the outer one envelops the whole penis, and may be removed and re-wetted by the patient, though usually it is sufficient for him to keep it wet by dropping on a little lotion from time to time.†

After circumcision the patient should rest as much as possible. Thus, an adult should stay in bed for forty-eight hours and keep on the sofa for a week, alternate stitches being removed at intervals. If he insist on getting about too early, he must run the risk of the parts remaining long œdematous and tender. And for this reason,

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[*] This must on no account be cut away, as in it run the vessels to the prepuce. All bleeding must be stopped, especially in adults, or extravasation of blood in the loose connective tissue leads to tension, cutting through of sutures, and sloughing.

[†] Mr. Ballance (*St. Thomas's Hosp. Reports*, vol. xvi. p. 198) advises a dry dressing of gauze, the outer and larger covering being of a single layer, and its margins kept in position by collodion. This simple and ingenious mode of dressing will be found most effective in the later stages of a very large number of cases besides circumcision — *e.g.*, amputations, removal of breast, partial thyroidectomy, &c. In addition to the above advantages, it is cool and light dispensing, as it does, with bandages, and inexpensive as well.

with hospital patients who have to come backwards and forwards, early and complete healing is not to be expected.

AMPUTATION OF THE PENIS (Fig. 156).

Indication.—Epithelioma of penis. I would refer my readers to the remarks made at p. 358 on the pre-cancerous stage in epithelioma of the tongue. Though epithelioma of the penis is much less common, lives are, here also, too often lost by allowing the case to get beyond this stage. Any suspicious excoriation, ulceration, or wart should be early destroyed with the acid nitrate of mercury, or excised. Where, after this treatment, satisfactory healing does not take place, early and thorough removal of the part should be performed. There should be no dangerous waiting, because the surgeon is unable to satisfy himself whether the case is one of inflammatory induration or infiltration from new growth. In such cases, especially where there is a doubtful history of syphilis, much valuable time has been often lost with drugs, which, even if the lesion does date back to some long-past syphilis, are quite useless if epitheliomatous ulceration has set in. Furthermore, the longer ulceration continues, the more extensively will the inguinal glands be involved. In such cases, though the penis may be satisfactorily operated upon, disappointment will speedily follow, owing to the outbreak in the inguinal regions. Scarcely any surgical case presents a close more distressing, both to the patient and those around him, than one of breaking down of epitheliomatous glands, owing to the hideous ulceration, the noisome discharge, and the steady decay of bodily strength.

In a very few cases, when the disease commences around the meatus, it may still be possible to remove the affected part without interfering with the body of the penis. It seldom happens, however, that we see the case early enough for this, and it is usually necessary to remove the whole of the glans and more or less of the corpora cavernosa. Before doing this, the prepuce, unless it admits of being retracted, should invariably be laid open, so as to expose the growth and make quite sure of its real nature.

Operations.

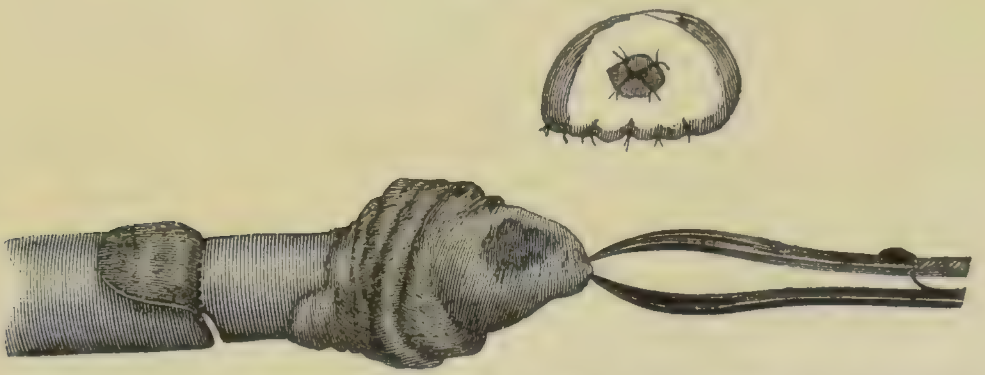
I. **Galvanic Cautery.**—I am as much against this method here as in the case of the tongue (p. 374). The dread of hæmorrhage still induces some to resort to it; it is not, however, a sure preventive. Sharp bleeding has followed a few hours after the operation, and also later on during the detachment of sloughs; furthermore, this operation leaves a much more troublesome and sloughy wound than the knife. This is not a matter of slight importance in these patients, in whom, usually advanced in years or prematurely aged, pulled down in health, and often depressed in mind, tedious healing of the wound (which it is difficult to keep sweet), involves a prolonged keeping the patient on his back, with the risks of broncho-pneumonia, erysipelas, &c. The need of a special, expensive instrument, and the unpleasant fœtor of the operation, are also objections.

If the surgeon make use of it, a No. 4 or 6 catheter should first be passed; the loop of wire is then tightened around the penis, well behind the disease, and kept there by one or two pins. When the current is passed, care must be taken that, by tightening the wire very slowly, and watching the amount of heat, the vascular structures are not severed too quickly; otherwise hæmorrhage, very difficult to arrest on a seared surface, is certain to follow. The catheter is cut through by the heated wire, and the urethra, thus maintained patent, is slit up and stitched as directed below.

II. **Circular Amputation.**—This gives good results, though not equal, in my opinion, to those which follow the flap method. The vessels being commanded by a clove-hitch, or by the clamp which bears Mr. Clover's or Mr. Durham's name, the skin is drawn a little forward to prevent any superabundance afterwards, and the amputation is effected by a single sweep of the knife. The vessels and the urethra are treated as directed below.

III. **Flap Amputation** (Fig. 156).—This method has been followed by rapid healing, and has given an excellently covered stump in the six cases in which I have made use of it. Hæmorrhage being provided against by one of the above-given means, the surgeon enters a narrow-bladed knife, at a point well behind

Fig. 156.



Flap amputation of the penis. The appearance of the stump, with the urethra slit up and stitched *in situ*, is shown above. The raw surface from which the dorsal flap has been raised should have been shown in the lower figure.

the disease, between the corpus spongiosum and the corpora cavernosa, and then cuts forward and downwards for about ¾ inch. From this small inferior flap the urethra is dissected out. A flap of skin is now cut from the dorsum and sides of the penis, resembling in miniature the upper skin-flap in amputation of the thigh. This flap being held back, the corpora cavernosa are divided vertically upwards on a level with the point of transfixion. Any vessels which can be seen are now tied with chromic gut or carbolized silk. On removal of the clamp or clove-hitch, and securing any spirting vessels, free oozing often persists for a few minutes, but ceases spontaneously. All hæmorrhage being arrested, the upper flap is punctured, and the urethra drawn through the face of the flap, slit up, and stitched *in situ.* The two flaps, upper and lower, are then united by a few points of carbolized silk and horsehair suture.

This method secures a natural skin-covering for the severed corpora cavernosa, and prevents the delay and irritation which healing by granulation entails. A circular operation was long ago suggested by Prof. Miller of Edinburgh, but this surgeon cut his flap from below. If, as I have recommended, the flap is taken from above, the skin will be found to fall into position more readily over the raw surfaces of the corpora cavernosa.

Occasionally, **severer operations** are entirely justifiable. Thus, where the penis is involved as far back as the scrotum, the entire penis should be extirpated, if the inguinal glands are not seriously involved, and if the powers of repair are satisfactory. The patient being in lithotomy position, the scrotum is to be split deeply along the whole length of the raphé, and the corpus spongiosum carefully dissected out. This step may be facilitated by passing a large sound. When the triangular ligament is exposed, the above instrument is removed, and the corpus spongiosum which has been dissected out is cut through, enough being left to bring out in the perinæum. By means of a blunt dissector, the crura are then detached on either side from the pubic arch, and the incision being prolonged around the penis above, the suspensory ligament is divided, and the dorsal arteries secured. The cut end of the corpus spongiosum is now slit up and stitched in the posterior part of the scrotal incision, and all the rest of the wound closed by sutures. Drainage must be provided by a small tube, or by horsehair drains. Similar operations to the above have been performed on several occasions, but the important modification of dissecting off the crura, and thus ensuring complete removal of the cancerous organ and its capsule, was brought before the notice of English surgeons by Mr. Gould.*

Question of Removing Enlarged Glands.—These should always be extirpated as soon as it is probable that the enlargement is not merely inflammatory. A week's watching, with rest, lead lotion, or the inunction of mercury oleate (10 per cent.), aided by pressure, will settle this point. As long as the glands are involved only by growth, hard and separate from each other, careful dissection will often succeed in shelling them out, and thereby add materially to the prolongation of the patient's life. But where they contain not only secondary deposits, but also inflammatory matter, owing to ulceration having set in at the seat of the primary lesion, satisfactory removal of the glands is always a matter of great difficulty and often impossible, owing to their softness and tendency to break down, to their adhesions to their capsules, and the matting of these to the surrounding parts, the vascularity of which is increased, and tendency of the overlying skin to become adherent.

In all such operations the parts should be disturbed as little as possible, as erysipelas, sloughing, and superficial gangrene are very likely to follow these operations where planes of fascia are much interfered with, and where the blood-supply is but poor.

The wound should be syringed from time to time during the operation with a solution of mercury perchloride, glycerine and water, 1 in 1000.

Iodoform and sal-alembroth gauze dressings, or boracic-acid lotion, if erysipelas is feared, will be found the best.

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* *Lancet*, May 20, p. 821.

CHAPTER XV.

OPERATIONS ON THE SCROTUM AND TESTICLE.

RADICAL CURE OF HYDROCELE.*—VARICOCELE.—CASTRATION.

RADICAL CURE OF HYDROCELE (Figs. 157, 158).

In a paper written fourteen years ago (*Lancet*, Sept. 1, 1877), I drew attention to the uncertainty of the radical cure of hydrocele by iodine injection, as usually practised. Thus, out of forty-four cases treated with solutions of iodine and potassium iodide at Guy's Hospital, I found that the treatment failed in eight cases, and that in two it failed twice.

Latterly, I believe that surgeons have recognized that the risk of recurrence is greater than that of excessive inflammation, and stronger solutions have been made use of—*e.g.*, the Edinburgh tincture of iodine—and some of the injection has been allowed to remain. As it is still a fact, however, that no method of cure can really be relied upon as radical for this troublesome complaint, the three following will be mentioned here—viz.:

i. **Iodine Injection.** ii. **Injection of Carbolic Acid.** iii. and iv. **Antiseptic Incision and partial Excision.**

i. **Iodine Injection.**—Supposing the patient be healthy, not prematurely aged, and amenable to directions, the surgeon naturally begins with this as less painful, necessitating no open wound or dressing, and finally, as necessitating much less of the recumbent position.

I have already drawn attention to the frequency with which recurrence is liable to take place if dilute injections are used. Elsewhere† I have written as follows:—" While I believe that the absolute certainty of iodine injection has been over-estimated, yet there is no doubt that failure is too often courted by want of the following precautions:—(*a*) The use of a too dilute solution; (*b*) Not bringing the solution in contact with the whole of the sac; (*c*) Not withdrawing all the hydrocele fluid; (*d*) Injecting large hydroceles immediately after they are emptied; (*e*) Making use of iodine in unsuitable cases—viz., hydroceles with thick walls."

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* The methods of injection given below refer to hydrocele of the tunica vaginalis and to encysted hydrocele. Antiseptic incision and partial excision of the sac is applicable to all the varieties of hydroceles, including the congenital.

† *Syst. of Surg.*, vol. iii.: "Dis. of the Male Organs."

The method of injection with iodine should be carried out as follows:—The patient's bowels are cleared out for a day or two before, and it is well for him to rest with his hydrocele well supported for twenty-four hours previous to the injection. The fluid is first most carefully drawn off with a medium-sized trocar,* the surgeon then, by means of a syringe with a platinum nozzle accurately fitting the cannula, injects steadily 2 to 3 dr. of the tincture of iodine (*Edin. Pharm.*), taking care first that the cannula is well within the cavity of the tunica vaginalis. I now plug the cannula with a small wooden spigot, while the affected side of the scrotum is gently manipulated and shaken so as to bring the fluid in contact with all the interstices and folds of the serous membrane. In five or ten minutes the cannula is withdrawn, as in most cases it is quite safe to leave in the above given amount of iodine. The puncture is kept carefully closed around the cannula while this is taken out, and then closed with iodoform and collodion. A feeling of heat is noticed during the injection, sometimes amounting to sickening pain, referred also to the inguinal and lumbar regions, and the neck of the bladder. Faintness is not very infrequent, and it is thus well to tap and inject the patient while he stands at the end of a sofa, or lies down.

The after-treatment depends on the amount of inflammation. In most cases there is too little rather than too much of this. It usually appears within two or three hours, and if it be slight or delayed, the patient should be told to walk about a little, and the sac again frequently manipulated. The patient should be kept to his bed or sofa for a day or two, the scrotum supported, and plain diet given. There should be no hurry to employ ice, this being only made use of if the swelling promises to be great. Morphia may be given freely. Within four or five days usually the patient may get about wearing a suspensory bandage. He should be prepared for a return of the swelling after the injection, otherwise he will be disappointed at what he considers a recurrence of his disease. The swelling, as a rule, disappears in three to four weeks.

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* By some a solution of cocaine is now injected. I prefer not to use this, if possible, that no dilution of the iodine injection may occur.

In the case of a double hydrocele, if the patient be healthy and not advanced in years, it is quite safe to inject both sacs at the same time, but in elderly or weakly subjects, antiseptic incision will be the safest course if the patient desires an operation, otherwise an interval should be allowed between the two tappings.

ii. **Injection of Carbolic Acid.**—This method, very largely used in America, was introduced by Dr. Levis, of Philadelphia, who recommends it as exciting just the required amount of inflammation and no more, and as being less painful than the iodine injection. After tapping the hydrocele, Dr. Levis, by means of a syringe having a nozzle sufficiently long and slender to reach entirely through a similar cannula, injects about ʒj of crystallized carbolic acid, maintained in a liquid state by the addition of 5 per cent. of glycerine or water. No more fluid is to be used for dilution than is absolutely needful. Liquefaction by heat will not answer. When the carbolic acid is introduced it is diffused throughout the tunica vaginalis by gently shaking the scrotum. A sense of warmth is produced, soon succeeded by numbness. In the greater uniformity of its action, the less pain it causes, and shorter rest which is needed, the injection of carbolic acid is superior to the older method by iodine. But it is a mistake to speak of it as an absolutely perfect method. Suppuration is not unknown. Rare instances of recurrence have also been published. Recurrence may take place even after incision and partial excision of the sac (p. 986), and it will certainly be met with, now and then, here.

iii. and iv. **Antiseptic Incision and Partial Excision of the Sac.**—This method has the advantage of being more certain than that of injection. While rendered safe, nowadays, by aseptic treatment, it has the disadvantage of being more severe. Thus an anæsthetic is required, an open wound is present and several dressings are needed.

It would appear especially applicable to cases (*a*) of previous failure with iodine; (*b*) with a sac very large, or with very thick walls; (*c*) where, on account of ill health or premature age, the risk of inflammation after iodine injection is especially to be dreaded; (*d*) in cases of congenital hydrocele (Fig. 157) a careful incision with (Fig. 158) antiseptic precautions will be safer than any other method, if the pressure of a truss for the obliteration of the peritonæal communication cannot be persevered with; (*e*) where the surgeon wishes to explore the sac of the tunica vaginalis, as in cases where doubtful enlargement of the testis co-exists with hydrocele, and does not yield to ordinary treatment; (*f*) where two hydroceles co-exist—*e.g.*, vaginal and encysted hydroceles; (*g*) in some cases of hydrocele complicated with hernia—*e.g.*, where the bowel is irreducible, and where, especially in unhealthy patients, there is a risk of the inflammation set up by the iodine extending to the hernial sac.

FIG. 157.*

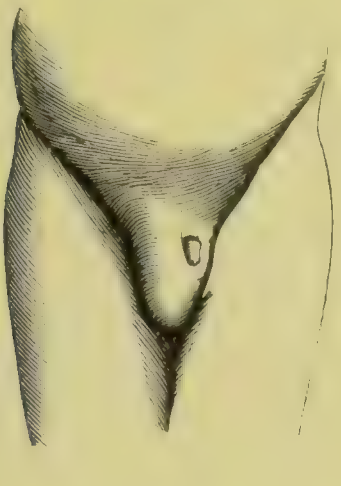
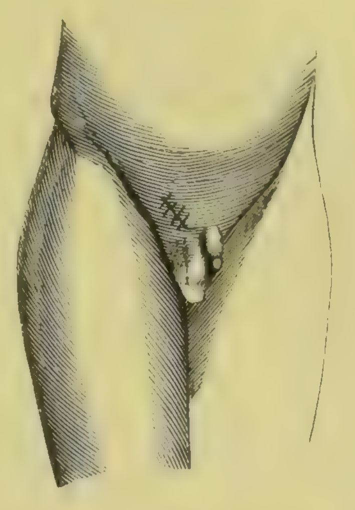


FIG. 158.*



Incision.—The parts being shaved and cleansed, an incision, quite 2 inches long, is made, with strict antiseptic precautions, over the lower and front part of the hydrocele, which is made tense with the left hand. This incision goes down to the tunica vaginalis, and the next opens this cavity freely. This is most essential, as, the fluid having gushed out, the long-stretched dartos at once contracts, closing up at once an apparently free incision, inverting the edges of the scrotal skin and throwing the cavity of the tunica vaginalis into a number of folds. To facilitate the introduction of drainage-tubes, and thus the obliteration of the sac from the bottom, the cut edges of the tunica vaginalis and the skin are now united by numerous points of chromic gut. Unless this is done, the action of the dartos so puckers together the folds of the tunica vaginalis that some of these remain unaffected, and recurrence of the hydrocele may easily take place. These sutures should pass through any bleeding-points in the incision. After the insertion of one or two drainage-tubes, iodoform is dusted on and gauze dressing applied. The scrotum must be kept well suspended, and a separate pad of carbolized tow or iodoform wool placed in the perinæum to shut off the anus. The dressings will require changing once in three days, or whenever they are loose, and the drainage-tube must be gradually shortened. In about ten days the granulating spot that remains may be dressed with resin ointment. For the first few days some amount of orchitis is usually present; when this subsides the patient may get on to the sofa.*

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* Large congenital hydrocele in a boy of twelve before and after antiseptic incision. To close the communication with the peritonæal cavity, a truss was worn for a week before the operation. In order to get at the neck of the swelling, and to ligature the processus funicularis as high up as possible, and thus prevent any risk of subsequent hernia, I made the incision higher up than when incising the ordinary hydrocele of later life.

Excision.—This method is indicated in cases of previous failure, and in those where the tunica vaginalis is much thickened, or the seat of calcareous plates. This operation will rarely be required if that of incision is carefully carried out, so as to secure alteration of the whole of the lining membrane. The hydrocele being opened freely, the parietal part of the tunica vaginalis is stripped away from the scrotum, much as the sac of a hernia is dissected out. It is cut away close to the testis and epididymis, and all bleeding-points tied with chromic gut.† The upper part of the wound is then closed, and the lower left open for drainage.

It cannot be too strongly pointed out that a certain number of hydroceles will be found most rebellious to attempts at radical treatment. Thus, in one case of mine, recurrence followed after injection with undiluted Edin. tincture of iodine, and again after incision and drainage. A cure took place after again incising the sac, and wiping over the interior with a stick of nitrate of silver.

Mr. Morris, in a paper read before the Medico-Chirurgical Society (*Lancet*, March 3, 1888), drew attention to this matter. He has met with two cases in which recurrence actually took place after excision of the sac.

At the discussion on the above paper the president, Mr. Pollock, mentioned a case under his care which had been tapped and injected twice, and followed by recurrence. A seton was then passed through and kept in for three weeks; this likewise failed. The sac was then incised and dressed with lint from the bottom, causing profuse suppuration. On allowing the wound to heal, the hydrocele again returned, and it had since been treated by simple tapping. Mr. Treves put the failures after incision and excision as high as 25 per cent. He now practised incision and swabbing out the sac with crude carbolic acid, which destroyed the endothelium and set up suppuration.

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* Out of fifteen cases of antiseptic incision two recurred. One of these is mentioned below. In the other, a case of bilateral hydrocele, the recollection was small, and had remained so in a stationary condition when I saw the patient two years afterwards. Two of the cases were encysted hydroceles, but five occurred so early in life as to need further watching before they can be claimed as permanent cures.

† These are often numerous, especially if a previous injection with iodine has failed.

Causes of Failure and Trouble after Operations for Radical Cure.—These fall mainly into two classes:

(1) Recurrence.—This is often due to the use of too diluted injections (p. 983), more rarely to the inveteracy with which some hydroceles recur (*vide supra*).

(2) Septic troubles.—These should be practically unknown nowadays. Their importance formerly is shown by two cases given by Sir A. Cooper in his work on the testis, in which fatal cellulitis followed very quickly after he had tapped a hydrocele.

VARICOCELE (Fig. 159).

Indications.—While palliative treatment will be sufficient in the great majority of cases, if, at the same time, due attention is paid to the general health, the occupation and habits of the patient, and, where this is required, to his sexual hygiene, an **operation** will be **justifiable** in the following cases:—(1) Where, in spite of treatment, a varicocele steadily increases, and where it is accompanied by much annoyance, distress, and pain; (2) where the patient is prevented from entering one of the public services, or any active life in which he has good prospects;* (3) where the surgeon has satisfied himself that the testis is undergoing atrophy.

The **choice of operation** is a very large one, but the following will be found the simplest and most efficient. The first is far the safest, and will replace all others:—

i. **Antiseptic Excision** (Fig. 159).—This plan ensures obliteration of the varicose veins without risk of septic cellulitis and secondary hæmorrhage, or fatal thrombosis and pyæmia. We owe it to my colleague, Mr. Howse.† The bowels having been cleared out, the parts duly shaved and cleansed, the vas is carefully isolated, and given to an assistant to hold. An incision 1½ to 2 inches long is now made over the varicocele thus made prominent, usually beginning about ½ inch below the external abdominal ring. The overlying tissues should be carefully incised until the veins bulge bare into the wound.‡ An aneurism needle, threaded with chromic gut, is now passed at the upper and lower angle of the wound, so as to include a portion of these veins, proportionate to the size of the varicocele. The ligatures being tied and cut short, the included bundle of veins is clipped out with blunt-pointed scissors. The remaining veins and the vas deferens are then carefully replaced. Every care should be taken to disturb the parts as little as possible, especially the connective tissue about the vas, as in this run a number of small veins which, if undisturbed, are quite sufficient to carry on the circulation.* The testis should also be kept down by the finger of the assistant who has charge of the vas deferens, as it has a tendency to protrude when the vas is pulled upon. A little iodoform is then dusted on, a horsehair drain inserted, the wound united with carbolized silk and horsehair sutures, and aseptic gauze dressings applied. Strict antiseptic precautions are required throughout. The wound should be dressed on the fourth day, to remove the drain, and again about four days later, to remove the sutures. The recumbent position should be maintained for three weeks. In my last six cases I have united the two stumps of tied veins by a chromic-gut suture, which is cut short and dropped in the wound. This suture has the effect of shortening the cord, and aids the raising of the testicle.

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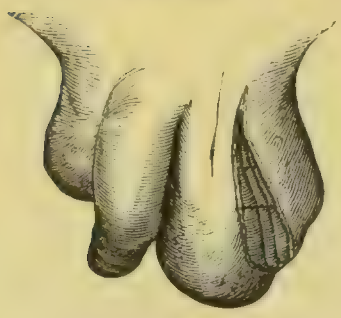
* As in the case of two of my patients, a goods-guard and a policeman.

† *Guy's Hosp. Reports*, 1887, vol. xxiii. p. 468.

‡ Care must be taken to expose the veins thoroughly, otherwise difficulty will be experienced in passing the ligatures.

FIG. 159.



Some of the scrotal skin should always now be removed at the margins of the wound, and any enlarged scrotal veins tied; but neither of these steps are of the least service without ligature of the varicocele itself, and they are the less needed if the above precaution is taken of suturing together the vein-stumps, and thus shortening the cord.

Mr. Bennett, in a very interesting lecture on the Radical Cure of Varicocele (*Lancet*, 1889, vol. i. p. 264), recommends a modification of the above method. Thus he does not open the fascia immediately surrounding the veins, as thereby there is less risk of any enlarged veins escaping, and, as the fascia, if left unopened, better carries the weight of the dependent testicle, when the ligatured stumps of veins are united. In the *Lancet*, 1891, vol. i. p. 532, Mr. Bennett goes further and advocates still more radical measures. Thus, amongst his conclusions are the follow-

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[*] See fig. 113, p. 566, of my article on "The Diseases of the Male Organs," *Syst. of Surg.*, vol. iii.

ing:—(1) That the vas deferens having been displaced in the usual manner, the spermatic artery does not accompany it, but remains with the spermatic veins. (2) That the spermatic artery is usually, and may be always safely divided, together with the spermatic veins; for as long as the wound remains aseptic, the artery, with the vas deferens and other small anastomosing branches, will suffice for the supply of the testicle. I cannot agree with Mr. Bennett that it is safe to trust to the deferential and other small arteries for the preservation of the testicle, especially in large varicoceles. And while Mr. Bennett's plan answers well in his own practised hands, I strongly advise my younger readers to make use of the simpler and very efficient method given at p. 987.

Subcutaneous Methods.—In these it is sought to obliterate the veins either by a ligature passed subcutaneously,* or by a tenotomy knife introduced by a puncture, the veins having been first tied subcutaneously, or temporarily compressed by hare-lip pins and figure-of-eight ligature.† I have not described these, as I consider the "open method" quite as simple, and more certain and more safe. The subcutaneous method is less certain, owing to the difficulty which must now exist in deciding as to whether a sufficient number of veins have been included; it is less safe when the ligature is passed by a needle around the veins, from the risk entailed of transfixing one or more veins, and thus of causing septic thrombosis.

Difficulties and Causes of Trouble in the Radical Cure of Varicocele.—These fall into two classes.

1. Sepsis and its Results.—The risk of these is always present with the old subcutaneous operation. A good instance of these has been recorded by Mr. H. Lee (*Clin. Soc. Trans.*, vol. i. p. 73). Here erysipelas, repeated hæmorrhages, sloughing of the skin of the scrotum and penis, and multiple abscesses, followed on Mr. Lee's operation performed by himself. It is certain that others have not been so candid. As Mr. Lee mentions local abscesses, destruction of a small portion of skin, and, on two or three other occasions, arterial hæmorrhage controlled by introducing a third pin, as having happened with his experienced hands, surgeons will prefer the open and aseptic operation. The small wound made here usually requires only three dressings. In both cases a suspensory bandage will be required till all trace of the inflammatory thickening has disappeared; this will take six to eight weeks.

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* Erichsen, *Surg.*, vol. ii. p. 960.

† Curling, *Testis*, p. 513, fig. 44.

2. Inclusion of too many Veins.—That this is a real danger is shown by a case of mine which I have published.* The patient here had a double varicocele, that on the left side being truly enormous. This was my third case, and was operated on with the same precautions as to the vas and asepsis given at p. 987. Owing to the huge size of the varicocele, three bundles of veins were removed, and even then a large number appeared to be left, the varicocele being now a quarter of its former size. The case did well up to the eighth day, when the wound opened and the lower half of the testis, evidently gangrenous, presented itself. This was cut away after the application of a chromic-gut ligature. Though, at the close of the operation, it did not appear that too many veins had been removed, such must have been the case.

Since this I have had eleven cases, which have all done excellently.

CASTRATION (Fig. 160).

Indications.

I. Growths of the testicle.

1. *Sarcomata.*—The following practical points deserve allusion. The *varieties* of round, spindle, and mixed-cell sarcoma are all met with here, together with the sub-variety of the first called lympho-sarcoma or lymphadenoma, from the likeness of its cells to those of lymphatic tissue. Of the above, the spindle-cell sarcoma is the one most frequently associated with other structures of the connective-tissue group—viz., cartilage, myxomatous, adipose, and even muscular tissue. While pure forms of sarcoma are not often met with in the testicle, the round-cell variety is the one most often met with in the unmixed form, thus accounting for its far more rapid growth, more marked tendency to secondary deposits, and thus its shorter duration. *Cystic Sarcoma.*—This is occasionally spoken of as a distinct disease; it means, I believe, only an early stage of sarcomatous disease, a stage of varying duration, but one that is very liable to be followed by rapid increase locally, and probably by secondary deposits elsewhere. The combination of cysts and sarcoma is very common, and is met with in two quite distinct forms: (*a*) Simple cysts, with a fibro-cellular wall and a lining of tessellated epithelium, and contents serous, viscid, or mixed with blood. This is the variety which is often called "cystic disease," and which is looked upon as innocent. While I grant that this form may remain long quiescent,

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* *Syst. of Surg.*, vol. iii. p. 571.

I think it should be looked upon as an early stage of sarcoma, though the date of its taking on dangerous growth is quite uncertain, and may be long deferred. (*b*) Proliferous cysts. Here the cysts contain sprouting, foliaceous or papillomatous growths, myxo-sarcomatous in structure, while the inter-cystic disease is also frequently myxomatous or myxo-sarcomatous.

2. *Enchondroma.*—I have elsewhere * expressed my belief that this is merely a variety of sarcoma, and being never really innocent, should be treated accordingly. Most frequently cartilage occurs in the testicle in combination with sarcomatous and cystic disease. Another, and, at first sight, quite a distinct form, is that in which the cartilage occurs in hyaline masses, and apparently without cysts and sarcomatous material. I believe that, clinically, it is extremely doubtful whether these apparently simple enchondromata may not, at any time, become sarcomatous. No doubt we occasionally meet with cases of enchondromata of the testicle which have been growing slowly for perhaps three or four years, and in which there may be no recurrence during the four or five years in which the patient remains under observation, perhaps for the rest of his lifetime. But when the close relations of cartilage to the other tissues of the connective type are considered, and when it is remembered how narrow is the border line between these tissues and sarcomata, especially when, submitted to irritation or inflammation, the former tend to recur to their embryonic forms, it may well be doubted if an enchondroma of the testicle ever really deserves the term "innocent."

3. *Cystic Disease.*—This has been already referred to, p. 990.

4. *Fibroma or Fibro-myoma.*—These are so rare as to need no further remark.

5. *Dermoid Cysts.*—These are also extremely rare.

6. *Carcinoma*—The encephaloid, a soft variety, is not unfrequently met with in the testicle. Of scirrhus a few authenticated cases are on record. Encephaloid carcinoma may make its appearance at any time of life, but it is most common in the first half of adult life—*i.e.*, from twenty to forty. It is rare after sixty, and practically unknown in infancy. It is usually rapid in all its stages, its average duration being from eighteen months to two years.

Diagnosis of Malignant Disease of the Testis.—As the records of surgery contain many instances of mistakes under able hands—hæmatoceles removed for malignant disease, and malignant disease opened for hæmatocele, a few hints may not be out of place here on the subject of castration. Sarcomata and carcinomata will be taken together. In the early stage these are liable to be confused with chronic inflammatory enlargements of the testicle, owing to their often possessing, at this period, an oval shape, a smooth outline, and a certain degree of hardness. A little later the indistinct fluctuation which accompanies the softening of the growth, coupled perhaps with the presence of fluid in the tunica vaginalis, causes a deceptive resemblance to an old hydrocele and hæmatocele, with thickened walls, especially where transparency is entirely wanting, and the tumour feels heavy and fluctuates obscurely.

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* *Syst. of Surg.*, vol. iii. p. 540.

The following are amongst the points on which most reliance may be placed:—(1) Continuously progressing solid enlargement without inflammation. (2) Unequal consistence of the swelling at different parts. (3) Entire absence of translucency. (4) Tendency of the scrotal veins to become enlarged, and of the scrotal tissues to become adherent. (5) Increasing aches or painfulness. (6) In doubtful cases additional information should be at once sought for by an antiseptic tapping or exploratory incision. The latter is preferable, as it gives more certain information, and is the best treatment in those cases of hæmatocele which are liable to be mistaken for malignant disease. Puncture of a malignant growth usually gives vent to blood-stained fluid, which is not large in amount, or to sero-mucous fluid, which is not blood-stained. On puncture of a hæmatocele there usually escapes either grumous altered blood or fluid blood, which flows for some time, producing a distinct alteration in the size of the swelling. (6) Enlargement of the cord, and *à fortiori*, that of the lumbar glands.

Results of Castration in Malignant Disease.—These may be considered from three points of view—(*a*) The danger of the operation. (*b*) The chances of cure. (*c*) The amount of relief which it gives when a cure is not afforded.

(*a*) *The Danger of the Operation.*—This is extremely small. The wound heals most rapidly if aseptic precautions are taken, and if no risk has to be run (as is very seldom the case) of encroaching on the peritonæum by slitting up the inguinal canal. (*b*) *The Chances of Cure.*—Permanent successes are very rare. This is mainly owing to the time lost in the early stage in administration of drugs and in strapping, and to the unwillingness of the patient to submit to castration. A few cases are on record which have been sufficiently watched to show how lasting may be the cure. Thus, Mr. Curling (*Dis. of the Testis*, pp. 341, 342) mentions four cases in which, after removal of the testis for soft malignant disease (whether sarcoma or carcinoma is not stated), life was prolonged for fifteen, five, nine, and twelve years, the patients in the last three cases being still alive when the last report was received. (*c*) *The Amount of Relief.*—Even when the cure is not permanent, castration may prolong a useful life, the patient, rid of a wearisome encumbrance, is made more comfortable, and, towards the close, death from internal deposits is not accompanied with the same distress, both to the patient and those around him, as when the disease is situated externally.

Contra-indications. — Castration should not be performed when the cord is extensively involved; when masses can be felt deep seated in the iliac fossa and lumbar region; when there is any evidence that the liver or lungs are involved; or when the jaundiced, sallow tint, and rapid emaciation point to the disease having become general. In cases at all advanced, though the patient might be rid of an encumbrance, the operation would be very liable to be followed by a low form of peritonitis, or, before the wound was healed, swelling would probably appear in the inguinal region, and the growth soon fungate through the wound.

II. *Tubercular Testicle.*—I am of opinion that castration should be performed much earlier in this disease than is usually the practice. Natural cures are so few, dissemination is so frequent and so grave, whether to bladder and kidneys, vesiculæ seminales, or prostate, or to the lungs,* while, on the other hand, castration is, nowadays, so safe an operation, that it should not be deferred.

Indications.—1. Failure of previous treatment. 2. Hernia testis. 3. Persistence of a discharging sinus affecting the general health, interfering with the out-door exercise so necessary to these cases.† 4. Commencing enlargement of cord, slight thickening of vesiculæ seminales. Nodules in the prostate still hard and craggy.‡

III. *Syphilitic Testis.*—Here, owing to the specifics which we possess, castration is much more rarely called for. The indications can readily be judged of from those above given.

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* Mr. Bennett, in a paper brought before the Medico-Chirurgical Society (*Brit. Med. Journ.*, January 28, 1888), showed that in each of his five cases the spinal cord became affected before any of the parts in the immediate neighbourhood of the testis, and that this spinal disease was markedly insidious. I should have thought the above coincidence of spinal disease with tubercular testis a rare one.

† Early phthisis should not interfere with removal of a tubercular testis which resists treatment and prevents the patient getting open-air exercise, and weakens his health by discharge. Owing to the condition of the lungs, chloroform should be here given, instead of ether.

‡ Tubercular disease of the prostate is a source, usually, of such extreme misery, that any existing cause in the testis should be removed very early.

IV. *Old Hæmatocele.*

Indications.—Failure of previous treatment, especially in a man of middle life whose activity—*e.g.*, in riding—is much interfered with.*

V. *Retained Testis.*

Indications.—1. When such a testis is the seat of malignant disease. 2. When it seriously cripples the patient by the recurrent attacks of inflammation associated with it. 3. When a co-existing hernia cannot be kept up by a truss, owing to the presence of the testis.

Much rarer indications† are:—VI. *Insanity, chronic epilepsy, &c., kept up by onanism.* VII. *Injury.* VIII. *The radical cure of hernia—i.e.*, when the operation cannot be completed without removal of the testis, owing to the firm adhesions of the sac to the cord, especially when this occurs in a patient approaching middle age. It is always well, here, to obtain leave for castration.

Operation (Fig. 160).—The absence of any hernia on the side operated on having been ascertained, and the parts duly shaved and cleansed, the surgeon protrudes the testicle with his left hand so as to make the overlying tissues tense, and divides them from the external abdominal ring to the bottom of the scrotum, so as to ensure free and easy drainage. In cases where the skin is involved by a growth, or ulcerated by a hernia testis, two elliptical incisions should be made, well wide of the disease, and meeting above and below. The first incision having exposed the cord above, this is defined, and the scrotal tunics are quickly shelled off with the right hand, while the testis is still further protruded with the left.‡ The spermatic cord is now isolated as high as may be needful, the inguinal canal being carefully opened upon a director, if this is necessary to get above the disease. An aneurism needle, threaded with a double ligature of carbolized silk or stout chromic gut, is passed through the cord, the loop of the ligature cut, the needle withdrawn, and, the cord having been tied in two halves, the ends of one ligature are cut short, while those of the others are tied round the whole cord to ensure that no vessel escapes. The ends of this also are then cut short. The ligatures being thus embedded in the cord substance, there is no risk of their slipping, and if they be tied as tightly as possible (by looping the ligatures round two pairs of scissors or forceps), there is no risk of causing the patient any suffering. Other methods consist in securing the vessels alone, singly, by torsion, or by chromic gut, or by fixing the cord in the upper angle of the wound with a clamp. The mode of ligature above given is much more speedy and also, I think, efficient. Securing each vessel is tedious, as it is needful to make sure of every one, even when they are not enlarged, a condition not infrequent in growths. If any of the arteries are left unsecured, dangerous bleeding, when the cord retracts upwards, calling for laying open of the canal, with the risk of cellulitis, is very probable.

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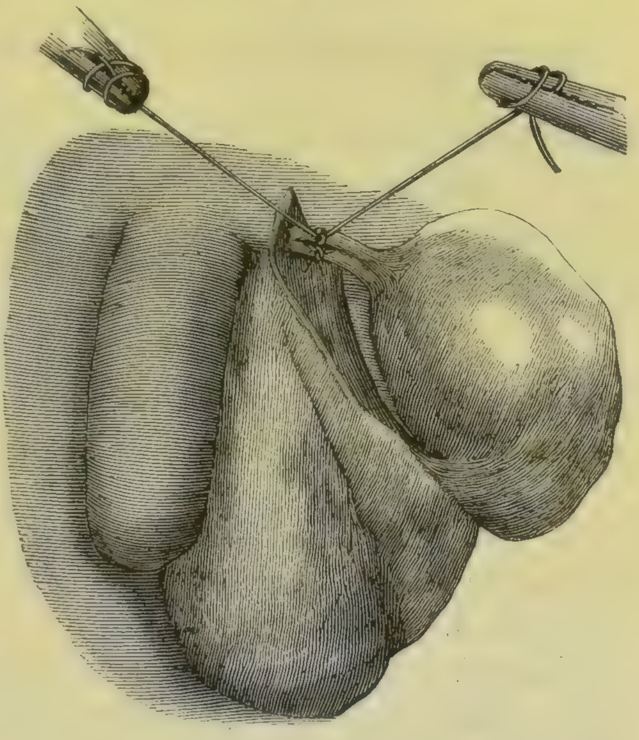
* The frequency with which malignant disease follows on repeated injury and irritation of the testicle is well known (Rindfleisch, *Path. Hist.*, vol. ii. p. 197).

† On these subjects I may refer my readers to my article already quoted from *Syst. of Surg.*, vol. iii.

‡ There is often an adhesion below, between the testis and the fundus of the scrotum (Fig. 160). This represents, according to some, the remains of the mesorchium.

FIG. 160.



The cord, being secured, is severed at least $\frac{1}{2}$ inch above the disease, and the mass removed. The wound is then examined in the case of a soft, rapid growth, and where a tubercular testis has threatened to fungate, any suspicious skin must be clipped away, or a sharp spoon freely used.

A few scrotal vessels, notably one in the septum, may require securing. The wound is then closed with carbolized silk and horsehair, pains being taken to meet the tendency of the scrotal edges to invert.

Drainage should be carefully provided, and every precaution taken during and after the operation (including irrigation with hydr. perch., 1 in 2000) to promote rapid healing, especially in hospital practice. Patients who have to submit to castration are often reduced in health, and are thus liable to erysipelas, and in septic cases a low form of peritonitis is very likely to follow, especially if the canal has been opened up, while septic thrombosis is very likely to follow on a wound made in a region so abounding in lymphatics and loose cellular tissue.

CHAPTER XVI.

OPERATIONS ON THE ANUS AND RECTUM.

FISTULA.—HÆMORRHOIDS.—FISSURE.— PROLAPSUS. —EXCISION OF THE RECTUM.—IMPERFORATE ANUS. — ATRESIA ANI. — IMPERFECTLY DEVELOPED RECTUM.

FISTULA.

Varieties.—As these have a very practical bearing upon the operation they must be alluded to here.

i. *Complete.*

ii. *Blind External.*—Here an external opening only exists, though in a considerable number of cases the internal opening is overlooked.

iii. *Blind Internal.*—An opening through the mucous membrane is here the only one.* This is the rarest, but an important variety, as, if overlooked, it is certain to be troublesome.

Situation of Openings.—Both of these are usually within an inch, more often ½ inch, of the anus. The internal one may be detected as a slight depression or papilla by the finger, or by the speculum, or, in obscurer cases, by Mr. Lund's method (p. 680).

Horseshoe Fistulæ.—Here an external opening on either side communicates with a single internal one, often at the back. This is an uncommon but an important variety, for if it is found necessary to cut through the sphincter ani at both sides, some loss of power is very likely to ensue. This risk should be explained to the patient, and the shallower fistula should be scraped, while the deeper is freely incised. If it is necessary to cut the sphincter on both sides, the knife should be employed on two distinct occasions, time being given for the first to heal.†

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* A discoloured dot or patch of skin sometimes marks the place where an external opening may occur. Mr. Lund (*Hunt. Lect.*, p. 88) relates a case in which a very chronic and slowly advancing blind internal fistula had excited, by its extreme end, just enough inflammatory thickening of the skin as to imitate a keloid growth, for which it was at first mistaken.

† Mr. Cripps (*Dis. of Rectum and Anus*, p. 165) shows that if, in women, the

Multiple Fistulæ.—This condition should always cause a suspicion of stricture, or extensive ulceration—*e.g.*, dysenteric, &c.

Fistula with Phthisis.—Where a fistula presents an external opening with undermined, livid edges, where the tubera ischii stand out prominently from emaciated nates, and where the hair of the part is long and curled, phthisis is always to be suspected, even if no history of cough or hæmoptysis are given.

Question of Operating on Phthisical Patients.—While each case must be decided by itself, the following remarks may be useful:—

Where the phthisis is advanced, the cough incessant, the fistula multiple or branched, an operation is out of the question. On the other hand, where the physical signs are little marked, night sweats slight or absent, where the fistula interferes with the patient taking the all-essential exercise, where the power of repair is good, an operation is indicated.

In cases intermediate between the above each one must be decided upon its own merits.

Before operating, the surgeon should remember that repair is here often sluggish, the mental condition much depressed. He should do all he can to improve the general condition before and after the operation. And if this can be performed in sunny weather, or, better still, at the sea-side, so that the patient can soon have fresh air in the recumbent position, so much the better.

Operation.—For a few days before the operation the diet should be restricted, and the bowels emptied by aperients. The hour of the operation should be so arranged as to give time for the enema which should be given to come away. The patient being under an anæsthetic, and either on his side with the knees well flexed, or in lithotomy position, the surgeon introduces lightly a fine Brodie's probe. In the case of a complete fistula, the internal opening being hit off (p. 996), the point of the probe is felt for by the finger and hooked out of the anus. If, after careful examination, the surgeon is satisfied that no internal opening exists, he makes one by finding the exact spot at which the coats of the bowel are most thinned, thrusting the point of the probe through here.

In the case of a blind internal fistula the internal opening must be found with a speculum, and the probe, curved, passed from this so as to project beneath the skin. In every case the whole length of the sinus between skin and bowel must be com-

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sphincter is cut through anteriorly where it decussates with the sphincter vaginæ, incontinence of fæces is very likely to take place.

pletely laid open. When this has been done, very careful examination is made for other sinuses by the introduction of the probe, and by pressure with the finger, which squeezes out any discharge, and feels for indurated tracks. Wherever these run, they must, if possible, be laid open. I have already (p. 996) alluded to the question of dividing the sphincter in two places. If any sinus seems to run dangerously high, hæmorrhage may be avoided by dividing it with a small écraseur, or, more gradually, by the elastic ligature. Every attempt, however, should be made with the aid of a good light and forcible dilatation of the sphincter to lay open every sinus with bistoury or scissors, extra care being taken, the higher the incision has to be carried, to arrest all bleeding with carbolized silk ligatures.

While the sinuses are being followed up, any old gristly tissue must be completely divided, all pyogenic or granulation tissue entirely scraped out, and all ill-nourished flaps and tags of undermined skin cut away.

If any troublesome piles co-exist they should be tied and cut away at the same time (p. 1000) or crushed (p. 1001).

As a dressing I prefer a little twisted cotton wool dusted with iodoform, as I find this adapts itself more easily to the different wounds. Less and less should be re-applied, daily, as granulations become established. Daily plugging with strips of lint out of carbolic oil only makes the wounds irritable and œdematous. After the first week little more is needed than daily cleansing of the wound with a camel's-hair brush, or a dossil of cotton wool on a Playfair's probe. If the edges of the wound close too soon they should be separated with a probe from time to time, or any redundancy may be painted with cocaine and snipped away.*

Finally, no operation better exemplifies the truth of Mr. Curling's saying, that the surgeon should be here his own dresser.

HÆMORRHOIDS.

Indications.

1. Continuance of hæmorrhage or discharge, and persistent liability to descent of piles in spite of judicious treatment.

2. Absence of albuminuria, diabetes, and hepatic (probably, cardiac) disease.

3. Amenability on the part of the patient.†

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* Another excellent dressing, later on, is dilute nitric acid lotion, 10 minims to 1 oz. This needs changing every four or six hours.

† In Mr. Cripps' words (*loc. supra cit.*, p. 99): "The smallness of the risk should not lull the surgeon into a sense of absolute security, and he should spare

Operations.

Ligature. — Cautery. — Crushing. — Acid. — Whitehead's Operation.

1. **Ligature.**—I have placed this first, from a strong belief that, if properly used, it is, on the whole, the best method and the one most generally applicable. Here, as elsewhere, that surgeon will have the best results who has thoroughly familiarized himself with the details of one operation. The following appears to me to be a fair way of putting the merits of ligature and the other operations:—

1. In my opinion the ligature is more generally suited to all cases. Again, it can be more easily applied to piles high up than can the cautery. 2. No special instruments are needed. 3. A ligature applied is done once for all; the cautery may have to be reapplied more than once if bleeding follows when the clamp is unscrewed. 4. The risk of bleeding is less, and hence this method is especially advantageous in anæmic patients, and in those for whom it might be difficult to immediately obtain surgical aid (Allingham). 5. The ligature is free from the objections to the cautery in private practice—viz., the smell, and, unless a Paquelin's cautery is at hand, the cumbersome apparatus otherwise rarely used.

Operation.—The preparatory treatment is that given at p. 997. The patient being on his left side, or in the lithotomy position, the anus should always be dilated. This may be done by introducing, and then separating laterally, the two thumbs, the pressure being steadily maintained so as not to rupture the mucous membrane; after a few minutes a sensation of giving rather than of tearing is perceived. Another method is to introduce a large bi- or multi-valve vaginal speculum, and to withdraw this expanded.* When the sphincters are thoroughly dilated the piles which lie lowest according to the patient's position† are drawn

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no effort in ascertaining the general constitutional condition of his patients. . . . . The amount of risk, slight as it is, should be clearly laid before the patient or his friends. If a man is to have some grave operation performed, such as the removal of a cancer or the amputation of a limb, both he and his friends are well aware of the risk involved, and are accordingly prepared. It is therefore in the smaller operations, regarded by the surgeon and public as free from danger, that a fatality, when it does occur, becomes so tragic from being unexpected."

* Eversion of the rectal mucous membrane by a finger in the vagina will often be most helpful in bringing piles within reach.

† This prevents the other hæmorrhoids being obscured with blood. Mr. Allingham advises that the smallest piles should be taken first, as there is a danger of these being overlooked and thus leading to a recurrence of the disorder.

down with a vulsellum or tenaculum-forceps, and the surgeon with blunt-pointed scissors, curved on the flat, cuts a groove around the lower two-thirds of the pile, which is thus separated for this distance from the sub-mucous and muscular coats. In the lower piles this groove should commence in the sulcus, which marks the junction of skin and mucous membrane close to the anus. The object of this groove is twofold. It forms a bed in which the ligature can be sunk tightly, and, above all, it leaves a very small pedicle of tissues to be strangled. The groove, moreover, can be cut without risk of hæmorrhage, as, however large the pile, its vessels enter it from above, running into its upper part just beneath the mucous membrane. The surgeon then ties round each pile, which is now still further dragged down, a ligature of well carbolized silk, the strength of which he has previously tested. Sinking this into the groove, he tightens it up so as to embed his ligatures firmly, without cutting through the pedicle. About two-thirds of the pile are then cut away, enough being always left to ensure a safe hold for the ligature. In Allingham's *Diseases of the Rectum*, p. 146, the following most important practical point is insisted on. When the piles are separated from the bowel preparatory to applying the ligature, it is essential that the base to be ligatured should be as narrow as is consistent with safe securing of its blood-supply. For if many piles have to be tied, and their bases are left large and broad, when tied up they draw the mucous membrane together, and cause great narrowing of the rectum. In such a case it is almost impossible to introduce the finger, without force, beyond the parts tied. In other words, islets of untied mucous membrane, as wide as possible, should always be left beween the tied piles. This will secure the less pain, easier action of the bowels, and less risk of contraction. After every internal pile has been carefully treated in this way, the external ones are clipped away, care being taken not to encroach upon the junction of skin and mucous membrane, and not to remove subcutaneous tissue for fear of subsequent contraction. If any bleeding-points still persist, they should now be tied. The ligatures are all cut short, and lastly the stumps of the piles smeared with iodoform ointment, after some of the powder has been well rubbed in, are returned. A pad of lint well smeared with the same ointment is then applied, and firm pressure made with a T-bandage and the aid of a pad of salicylic wool, carbolized tow, or "tarred cotton."

ii. **Clamp and Cautery.**—This method has been perfected by

Mr. H. Smith.* The preparatory treatment and position of the patient are those already given. The piles being sufficiently protruded, and the anus forcibly dilated, they are drawn well down, one by one, with vulsellum forceps, and enclosed within the blades of the clamp, which is screwed tightly up. With scissors curved on the flat the pile is then so cut away as to leave a sufficient stump. This is then carefully and thoroughly seared down with a Paquelin's cautery, carefully kept at a dull red heat. If the iron sticks at any moment, owing to its cooling down, it should not be pulled away, but loosened by heating it up a little. The clamp-screw is then slightly relaxed, and if any bleeding takes place it is at once tightened up, and the cautery reapplied. Every care must be taken to burn down the stump thoroughly at the first attempt, for if this fail, and oozing take place, it is not easy to stop the bleeding from the tendency of the stump to slip through the slackened clamp. Each pile having been successively dealt with in this way, the stumps are smeared with iodoform ointment and pushed well up with a finger coated with the same.

This method is thought by some to secure more rapid healing with less pain than the ligature. This, however true of the old methods, does not hold good when the piles are freely detached and the ligature tied with the precautions already given. The clamp is less easily manipulated in the rectum, it is a special instrument not always at hand, and the smell entailed by the cautery is most unpleasing. The surgeon who uses it must be extremely careful to keep his seared surfaces as small as possible, and by no means to entrench upon the skin. It is well known how slowly, how painfully, and with what a tendency to contraction burns heal.

iii. **Crushing.**—This method was prominently brought forward by Mr. Pollock (*Lancet*, vol. ii. 1880, p. 1, *et passim*) as less painful than the ligature, and as leaving a mere thin and superficial fringe of dead tissue, instead of the slough of the clamp and cautery. The anus being fully dilated, each pile is drawn down with a vulsellum, and firmly crushed for a period varying from one to three minutes. The projecting part of the pile should then be cut away. The best instrument is Mr. H. W. Allingham's "screw-crusher." This has enormous power, and possesses the advantage that it may be introduced into the bowel. Skin should not be crushed, an incision being always made, when needful, at the junction of skin and mucous membrane. The upper part of the instrument should rest within the rectum, so as not to drag on the mucous membrane. Mr. Allingham (*Dis. of Rectum*, p. 133) has found that pain after this method is rather less than after the ligature, and that recovery is somewhat more rapid. Œdema of the parts outside may be very marked; "contraction so as to require dilatation by bougie or finger occurred about as frequently as after any other method of operation upon piles, but far less than after the cure by the actual cautery." Hæmorrhage is extremely rare after careful use of the screw-crusher. If it occurs, it is best arrested by leaving on a Spencer Wells' forceps. Mr. Allingham gives the following advice as to suitable and unsuitable cases:—"It may be used when the piles are small and not numerous, say three in number. It may be applied to remove a pile or two when operating for fistula. White piles and partial prolapse of the mucous membrane fall within the same category. I should not advise its use in cases of very large vascular piles, in which, from excessive hæmorrhage, the blood is poor and non-coagulable. In cases of anæmia as a result of hæmorrhage, in which recurrent or secondary hæmorrhage would probably cost the patient his life, this method is decidedly dangerous. It should not be used to remove inflamed piles. It is not wise to crush piles when the patient is at a distance from skilled assistance, for fear of hæmorrhage coming on."

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* Mr. H. Smith (*Syst. of Surg.*, vol. ii. p. 840) has almost entirely discarded the use of scissors, removing the clamped piles with heated cauteries instead. Three of these are figured.

iv. **Acid.**—This method, formerly much over-rated, should be reserved for that rare variety of pile, sessile, perinæal usually in position, and with a florid, granular surface. Vaseline being applied around, the surface of the pile is dried, and carefully rubbed over with fresh, strong nitric acid, or acid mercury nitrate, this being thoroughly applied with a glass rod or pointed bit of wood. The acid should be rubbed in and in, the pile being kept dry and the acid not allowed to run. Every atom of the florid surface must be converted into a brownish, shaggy slough.

Whitehead's* Operation of Excision of the whole "Pile-bearing" Area.—This extensive operation is intended to bring about a radical cure, its object being not only to remove any existing piles, but also all the mucous membrane in the lowest part of the rectum, which is the seat of piles, owing to the tendency of its veins to become dilated. Though Mr. Whitehead has performed this operation in three hundred cases without a fatal result or any drawback, I cannot but consider it needlessly extensive and severe, especially in patients of middle life, and in a part which cannot be kept sweet, even with the aid of iodoform. The operation by ligature, or by clamp and cautery, carefully performed, gives most excellent results, and in answer to Mr. Whitehead's argument, that as long as this diseased area is left to reproduce piles over and over again, no permanent cure can be expected, I may say that I have always found that, after one of the above operations has been properly carried out, the patient can easily prevent any recurrence by attention to common-sense details in daily life.

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* *Brit. Med. Journ.*, February 26, 1887.

The following criticism (Allingham, *Dis. of Rectum*, p. 139) appears to me soundly based :—" Mr. Whitehead terms his operation simple. Simple it may be, but difficult to perform, for with the anus rugose and elastic as it is, even after dilatation of the sphincters, it is not at all easy to separate the mucous membrane from the skin. The time required for the operation is an objection ; this process takes on an average at least thirty minutes, where a skilled surgeon can operate with the ligature in less than five minutes. The hæmorrhage by this method far exceeds the amount lost when the ligature is used, and this is of great importance in those patients who have already lost much blood from their piles. . . . . Two or three days after the operation the parts not unfrequently become swollen, and the mucous membrane then tears through the ligatures and retracts away from the skin. This leaves a large granulating surface which may occupy the entire circumference of the bowel, and cause troublesome contraction."

Operation.—The sphincters being thoroughly dilated, and the hæmorrhoidal area of mucous membrane made to prolapse, the line of junction of skin and mucous membrane* is looked for, and the latter divided along it all round the anus with blunt-pointed scissors. The cut mucous membrane is then dissected up, with forceps and scissors, from off the external and (in fact) the internal sphincter, till the whole of the pile-producing area of mucous membrane can be pulled down and drawn outside the anus. It is then cut away, bit by bit,† transversely at its still attached upper border, each portion as cut being at once attached to the cut skin with carbolized silk sutures. In this way the diseased area is removed as a complete ring of mucous membrane.

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* The "white line" of Mr. Hilton (*Rest and Pain*, p. 289, figs. 51 and 52).

† So as to diminish the hæmorrhage, which would otherwise be free at this stage.

Each bleeding-point is secured by torsion or forcipressure. Iodoform is dusted over the wound. The sutures are allowed to come away of themselves.

Causes of Failure and Trouble after Operations for Hæmorrhoids :—

1. Hæmorrhage.—This will be extremely rare if the ligature method be carefully employed. The conditions under which this complication may occur are cases of long-standing piles or prolapsus in weakly subjects, cases where the tissues are very friable, where the patient insists on getting out of bed to pass water, or where he strains very much at the first action of the bowels. If the surgeon be called upon to meet it, the best means is to apply a Spencer Wells' forceps, and to leave this *in situ* ; in a severer case, or where the above is not available, Mr. Allingham's plan of plugging should be used (*Dis. of the Rectum*, p. 67). Through a conical sponge a silk ligature is threaded from apex to base. The sponge, well dusted with iodoform and steel sulphate, is pushed 4 or 5 inches into the bowel, and the whole of the space below it is plugged with aseptic gauze. The sponge is now pulled *down* by the two ends of the ligature while the gauze is pushed *up*. The plug should be left in as long as possible, the patient being kept under the influence of laudanum. It is well to pass a large catheter through the sponge before this is inserted, to allow of escape of flatus.

2. Tedious Ulceration.—This is usually due to the patients getting up too soon. They should remain in a bed a week or ten days, and then be content to pass another ten or fourteen days upon the sofa.

3. Septic troubles.

4. Contraction.—This is usually stated to be only likely to occur when, in cutting away piles, especially external ones, the junction of skin and mucous membrane is trenched upon. But the fact is that where many piles have had to be removed, where islands of mucous membrane (p. 1000) have not been left between them, the ulcerated surfaces thus tending to coalesce, contraction of the surface as it cicatrizes is very likely indeed to lead to some narrowing of the lumen of the gut. This must always be prevented by the early passage of the finger of the surgeon in charge, this being repeated daily if any tendency to contraction is found. Where a stricture, generally about 1½ inches from the anus, has been allowed to form, the patient's condition is a most vexatious one, though it will always yield to the use of bougies, aided, if need be, by nicking of the contraction.

5. Abscess. 6. Fistula. 7. Bubo. 8. Pelvic suppuration. These four are given by Mr. Allingham (*loc. supra cit.*, p. 163) as sequelæ in unhealthy patients, especially if the healing has been accompanied by prolonged suppuration. The antiseptics of the present day should prevent this.

FISSURE.*—ULCER.

The operative treatment of these is so simple and so eminently successful, that it should be resorted to early in these cases.

Operation by Incision.—The preparatory treatment and the position of the patient are the same as those already given. The division of the ulcer may be performed in one or two ways—(*a*) From without; (*b*) from within the rectum.

(*a*) *From without.*—Here the ulcer, being fully exposed with a speculum—and the one which bears Mr. Hilton's name, with a movable valve, will be found the best—a small sharp-pointed bistoury is inserted a little beneath the base of the ulcer, and its point made to protrude in the bowel above it; the parts are then divided from without inwards through the centre of the ulcer.

(*b*) *From within.*—Here, the ulcer being also exposed, either by stretching the parts with two fingers or with a speculum, a straight blunt-pointed bistoury is drawn across the whole of the sore, through its centre.† Mr. Curling (*Dis. of the Rectum*, p. 12) has drawn attention to an important point here, and that is, that the fibres of the muscle at the extremity of the ulcer near the verge of the anus should be divided rather more freely than those above, so as to avoid any ridge or shelf on which the fæces would lodge.

There is usually no hæmorrhage to speak of, and the whole operation is so simple that it may be performed after an injection of cocaine, or with nitrous oxide gas, unless anything else—*e.g.*, attention to piles—is required. I prefer, however, to operate with ether or chloroform.

Of the two methods, I generally make use of the first, following Mr. Hilton. I consider it the more certain, and have never known of anything like incontinence in the nine cases in which I have used it. The second is rather the slighter operation, and also gives good results.

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* This condition, often called a fissure, nearly always amounts to an ulcer when it is carefully examined and the parts unfolded.

† Mr. Cripps (*Dis. of Rectum and Anus*, p. 176) says, "so as to divide about a third of the fibres of the external sphincter."

The position of these usually club-shaped ulcers is posterior. If one is met with anteriorly in a woman, it would be wiser to try the application of acids, or the actual cautery. See foot-note, p. 996.

The surgeon must be careful, when examining into the amount of repair a week or two later, not to do any damage with a speculum.

Operation by Dilatation of the Sphincter.—This is not only rough but uncertain, and should not be employed.

PROLAPSUS.

Indications.—Failure of previous treatment. Large size and long duration of prolapsus. Altered condition of the mucous membrane—viz., thickening or ulcers, the latter giving rise to hæmorrhage. Incontinence of fæces, especially when fluid, or of flatus.

Operations.

Acid.—Cautery.—Excision.

1. **Acid.**—Of these I prefer the acid nitrate of mercury. This method is especially applicable to the obstinate cases of prolapsus in children, where the bowel is constantly down. Though, if the application is made properly, only a sensation of burning is complained of, an anæsthetic should always be given. The patient being in the lithotomy position, or on one side, the prolapsus is carefully dried of all mucus, and the surgeon rubs in the acid with the aid of a glass rod or pointed pieces of wood, the adjacent skin being protected with vaseline.

Care must be taken not to rub in the acid too long or too vigorously, for if the inflammatory process set up affects deeply the sub-mucous tissue, a most troublesome stricture may readily result.

It is well to warn the patients that a second application may be required in severe cases.

The after-treatment is that given below.

2. **Cautery.**—In severer cases, or where the acid has failed, the following will be found efficient. The position of the patient is as for pile operations, but it is best to apply the cautery to the bowel *in situ*, though this may be used when the bowel is prolapsed.

Thus, the patient being in lithotomy position, and a duckbill-speculum introduced and held in contact with the anterior wall of the rectum, the blade of a thermo-cautery is drawn edgeways along the lower three or four inches of the opposite surface of the gut. The speculum being shifted, the anterior and lateral aspects are similarly treated in severe cases.

Care must be taken not to go *through* the mucous membrane, or septic mischief and sloughing may be set up in the cellular tissue beneath.

3. **Excision.**—In severe cases, in adults, when other methods have failed, this method should be resorted to, but even with the improvements of the present day there must always be a difficulty in keeping wounds here aseptic.

The patient being in lithotomy position, the prolapsus reduced, and the parts exposed by a duckbill-speculum, two or more elliptical pieces of mucous membrane are removed by pinching them up with vulsellum-forceps and cutting them away with a very sharp scalpel or scissors. Any bleeding vessels are then tied with chromic gut, and the edges of the wound united by horsehair or fishing-gut sutures, a horsehair drain being inserted first. Iodoform is then carefully dusted on, and the parts smeared with an ointment of the same.

The insertion of sutures has the advantage of preventing hæmorrhage and hastening the cure. The disadvantage is that an anæsthetic will probably be required for their removal. Especial care will be needed now not to break down the union with the speculum. The wounds must be irrigated frequently with a solution of hydr. perch. (1 in 2000), and a small Higgenson's syringe.

After-treatment.—After any operation for prolapsus, the patient must rest for three weeks on the sofa to allow of firm consolidation and cicatrization taking place. Light diet—mainly, milk—should be allowed at first, and the bowels should only be allowed to act every three days, and, if possible, while the patient is on his side.

EXCISION OF THE RECTUM.

Indications. Suitable cases.

1. Malignant disease of anus—*e.g.*, papillomata, or old condylomata becoming epitheliomatous, or epithelioma originating in some neglected fistula.

2. Malignant disease of rectum.—The extent and fixity of this must be most carefully investigated. If limited to the posterior wall of the rectum, even 4 or 4½ inches of bowel may be removed. If the disease have attacked the sides or the circumference, three inches in the male, but less than this in the female, may be removed as long as the bowel is fairly movable on subjacent parts.

This point, especially in the male, is rather difficult to decide, as even a normal rectum is closely connected to the prostate and urethra and base of the bladder. Mr. Cripps[*] (*Dis. of Rectum and Anus*) thinks that though the bowel in contact with the prostate may be diseased, it is a long while before the prostate itself becomes infected; in women, on the contrary, when the disease is on the anterior part of the bowel, the vagina and uterus quickly become implicated.

Mr. Allingham (*Intern. Encycl. of Surg.*, vol. vi. p. 122), from an experience of thirty-six cases,[†] considers that "extirpation of the rectum may be undertaken in any form of cancer which does not necessitate the removal of more than $4\frac{3}{4}$ or 5 inches in the male, and about 1 inch less in the female."

But it does not follow that because such large amounts of the rectum have been successfully removed, this step is always to be recommended. Far from it.

Most surgeons will not care to remove more than $2\frac{1}{2}$ or 3[‡] inches of the bowel, as beyond this limit the risks increase rapidly. It is not only that the limit of the peritonæum varies normally, but further, it can never be told how far the carcinoma has drawn this downwards. The risk of opening the peritonæum is referred to below.

It will be gathered from the above that removal of the rectum is an operation of limited application, and that it can only be recommended in a small number of the cases of malignant disease which here come before us. Such cases are those where the disease is well within reach—*i.e.*, not extending more than 2½ or 3 inches from the anus; cases where it is limited to the posterior or lateral aspects of the bowel, or if involving the anterior aspect—*e.g.*, limited in extent and movable on the subjacent parts; cases where there is no enlargement of the liver, abdominal, pelvic, or inguinal glands,* where the patient's general condition is sufficiently good to meet the calls of what may be a very severe operation. If in such instances the external sphincter can be preserved, the operation may be recommended, but it will be seen a little later that even in such favourable cases a successful result may be vitiated by the contraction which is only too likely to follow.

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[*] This surgeon, who has had large experience of this operation, writes: "It is well to remember in the female how near to the perinæum the peritonæal membrane descends, it being much more commonly at a shorter distance than 3 inches than at a distance in excess of that measurement. In the male, however, $3\frac{1}{2}$ to 4 inches from the anus is the common site for the reflection of the peritonæal membrane.

[†] Of 36 cases operated on since 1874 Mr. Allingham has been able to trace 26. Of these—

1 died about 4 years after the operation.
1 ,, ,, 3 ,, ,, ,,
2 ,, ,, 2 ,, ,, ,,
5 ,, over 18 months ,, ,,
7 ,, about 1 year ,, ,,
5 ,, from the direct consequences of the operation.
5 are known to be still alive.

[‡] After all, measurements are of only relative value here. There is an increasing opinion that successful excisions of the rectum are frequently made of no account by the subsequent contraction of the cicatricial tissue resulting from the operation. It is obvious that the dilatation which it is so needful to keep up in this operation must be increasingly difficult the higher the cutting has been carried.

Comparison between Excision of the Rectum and Colotomy.—The chief points calling for attention are—(i.) The mortality of the operation. (ii.) The duration of life after it. (iii.) The amount of comfort given by it.

(i.) *The Mortality of the Operation.*—In instituting a comparison on this head between colotomy and excision of the rectum, one important point must always be remembered—*i.e.*, that the latter operation is never performed under those unfavourable conditions of obstruction which, owing to the operation being often deferred till too late, render the mortality of colotomy such a high one. Turning to the mortality of excision by itself, without comparison with any other operation, we find that Mr. Butlin (*Oper. Surg. Malig. Dis.*, p. 241), who has collected one hundred cases from various sources, gives a mortality of 35. This death-rate of one-third he regards as far too high, and as capable of reduction by one-half, or even more, by attention to antiseptic details, and also by abandoning the practice of drawing down and suturing the cut bowel, a practice which has been largely followed at Vienna, and which, by causing retro-peritonæal suppuration, has greatly increased the mortality. While Mr. Butlin's criticism is, no doubt, a sound one, I venture to think that another point has been overlooked which will prevent any real reduction in the death-rate of excision. In this, as in every other novel and important operation, a large number of unsuccessful cases will remain unpublished, while every successful case is reported at once.

(ii.) *Duration of Life.*—With regard to this point, I think a larger number of cases will show that if the surgeon decides to advise, and the patient is willing to run the risk of, the more serious operation, the prolongation of life will be greater here than after colotomy, if the cases are wisely selected. I think that the above is borne out by the results of the statistics which we have. It is rare for patients after colotomy for carcinoma to survive more than one year and a half. Making due allowance for the advanced date at which cases of rectal cancer too often come under treatment, for the fact that excision will usually be performed in selected cases, and that thus colotomy will be reserved for those less favourable, I think the published cases of excision show a greater prolongation of life. Mr. Cripps speaks of six cases known to have been well at periods of two to four years after the excision, one of these showing the value of a second operation. Mr. Allingham's cases (p. 1008) show that in four death took place over two years after the operation, and that nine survived over eighteen months. Mr. Butlin quotes two cases of Fischer's claimed as complete cures, one of six years' duration, the other of three years and ten months.

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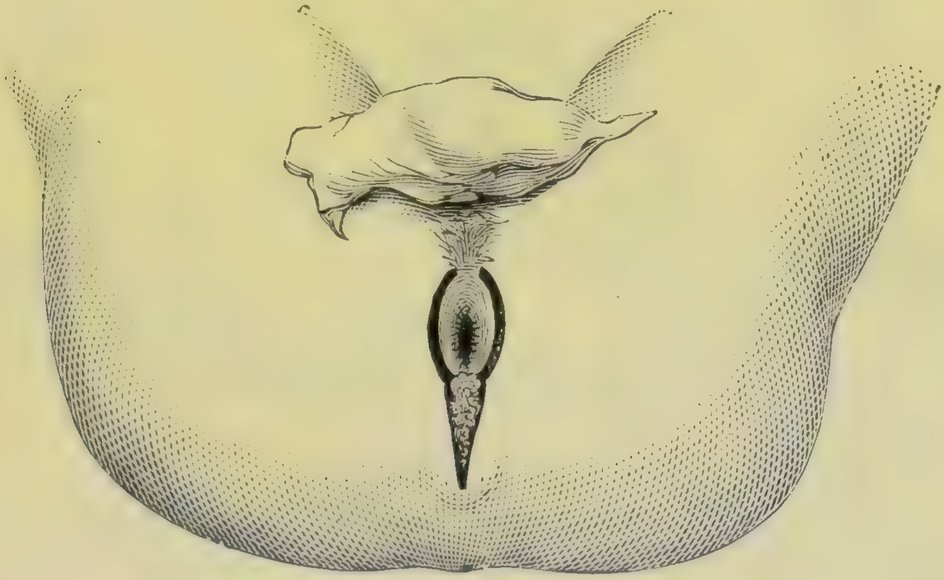
* The more rapid the growth and the younger the patient, the less favourable is the case for excision.

(iii.) *Amount of Comfort Afforded.*—After this operation, as after excision of the larynx, a distinction must be drawn between mere survival and what deserves the name of recovery. The amount of comfort enjoyed by the patient will depend on—(1) The amount of contraction that takes place. (2) How far he has control over his motions. (1) Where the whole circumference of the bowel has been removed, a matter referred to below (p. 1015), it is obvious that there must be a great risk of contraction in the scar-tissue which replaces the mucous membrane. This contraction forms a most serious difficulty in the after-treatment, and is liable to lead to most unsatisfactory results. The more the connective tissue around the bowel is interfered with, the more profuse the suppuration and the longer the healing, the more marked will the contraction be. Colotomy has been required for it, as occurred in a case under my care, where excision of the rectum had been performed elsewhere. The above risk may be obviated, no doubt, by drawing down the bowel and suturing it to the skin; but this step is not often feasible, especially in men, and if sutures are inserted they cut through quickly. It is at all times dangerous on account of the risk of leaving septic discharge pent up with very dangerous surroundings. Mr. Cripps finds that the severed end of the bowel is drawn considerably downwards during the process of healing. This renders it easier for the patients to pass a bougie from time to time, the need of which must be firmly impressed upon them. Another means of securing the patency of the bowel is by wearing a vulcanite tube, as recommended by Mr. Allingham. These are 3 or 4 inches long, with one end conical, and with the other ending in a broadish flange to prevent its slipping into the bowel, and also to enable it to be stitched to a bandage which keeps it in place. Patients begin to wear it about a fortnight after the operation, and, save for taking it out when the bowels act, retain it constantly for some months, some having to wear it for the rest of their lives.

(2) As to the power of retaining fæces, incontinence is always present at first, but control is usually regained after a time, save when the motions are loose. Mr. Cripps (*loc. supra cit.*) states that incontinence was present in only seven out of thirty-six cases which he collected.

FIG. 161.



(Allingham.)

Operation of Excision of Rectum in its Entire Circumference.—The bowels being well emptied by mild purgatives and an enema,* the patient, under the influence of ether or the A.C.E. mixture, is placed in lithotomy position, and the surgeon rapidly makes an oval incision into both ischio-rectal fossæ, around the bowel, then prolonging this oval incision backwards so as to reach the coccyx (Fig. 161). Mr. Allingham advises that the oval incision should be just above the external sphincter, or rather in the space between the external and internal sphincter, so as to leave the external sphincter (detached behind) attached to the skin. Better control over the motions is secured by this detail.

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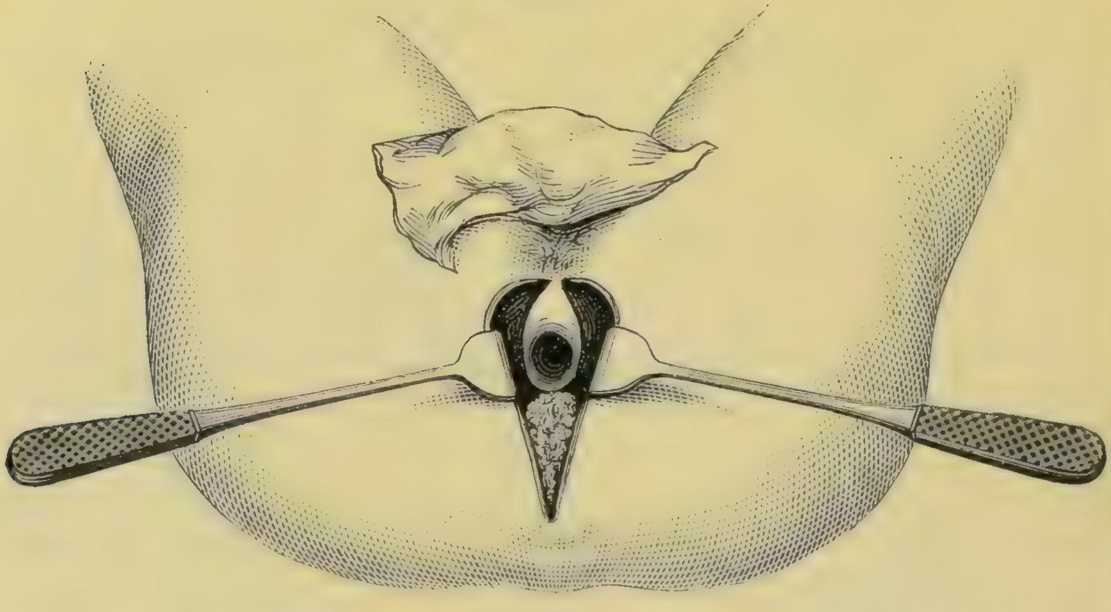
* Mr. Barker (*Man. of Surg. Oper.*, p. 313) recommends, in addition to copious enemata on the morning, an enema of brandy before the operation, as a general stimulant and an antiseptic.

This backward prolongation is much needed in order to give additional room for meeting hæmorrhage,* and for providing drainage later on. The fingers, aided if needful by the knife or blunt dissector, separate the bowel at the sides and posteriorly as high as the levator ani; the hæmorrhage is usually not severe, and can be readily arrested by pressure-forceps, sponges pushed into the incision, or by operating as rapidly as is consistent with safety. The separation of the bowel in front varies with the sex of the patient. In a male a full-sized metal sound being passed into the bladder and kept well hooked up under the pubes,† the surgeon carefully dissects away, partly with his finger and partly with scissors, between the bowel and urethra and prostate. These parts are naturally adherent, and this dissection must be carefully conducted, as any opening into the bladder or urethra will much increase the shock. If the left index be kept in the rectum and

FIG. 162.



(Allingham.)

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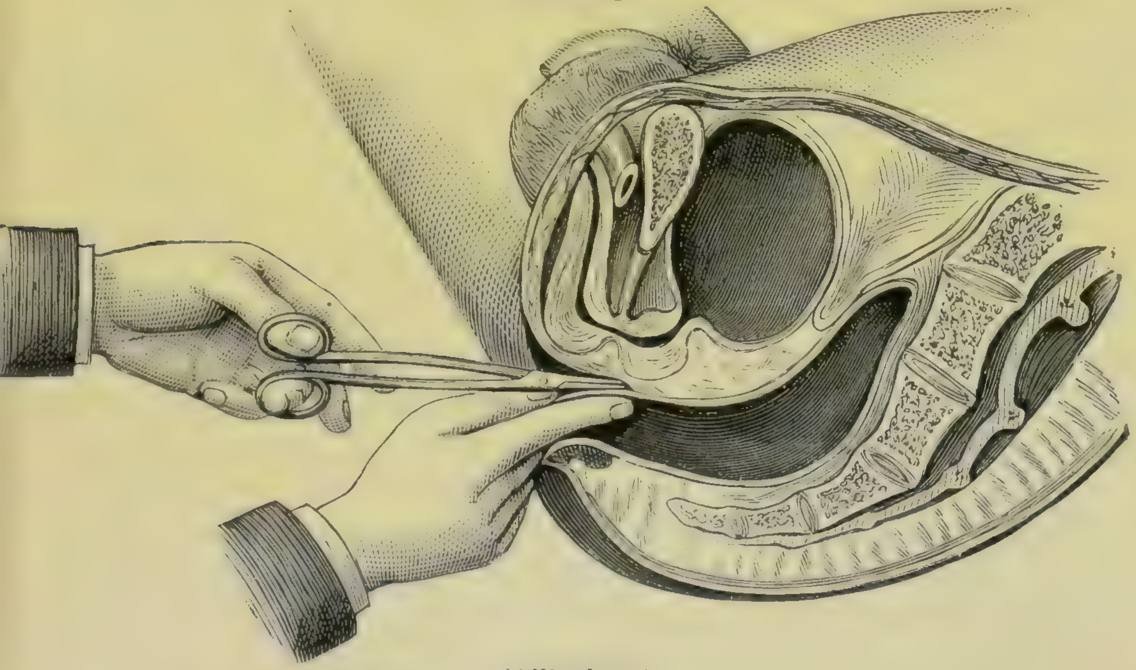
* If this incision has to be carried as high up as 3 or 4 inches, the hæmorrhage will be free, as the superior hæmorrhoidal artery here divides into two terminal branches. The free incision, well opened out with large retractors, will admit of easily dealing with this vessel. Another method is to begin by a free posterior incision, made by guiding a curved sharp bistoury well above the disease in the posterior wall, bringing out the point at the tip of the coccyx, and then cutting all the intervening tissues into the bowel. This exposes well the limits of the growth, but causes more bleeding. If the first method is made use of, the bowel must be laid open subsequently, to investigate the upper limits of the disease.

† Prof. Macleod advises that, if the disease is low down, it matters little whether the bladder is full or empty; if a higher portion has to be dealt with, as Dupuytren showed, the urine should be retained, so as to raise the recto-vesical pouch.

the thumb just outside it, they will serve to pull the bowel as it is freed away from the urinary tract, while the operator is at the same time kept informed how near to the bowel he is cutting (Fig. 163). In the case of a woman the surgeon's left index, or the finger of an assistant in the vagina, will give the best warning of his knife or scissors (the latter, long and blunt-pointed, are preferable) getting too near the vaginal mucous membrane.* If this be encroached upon, it must be removed without hesitation, in the hope that the cloaca thus formed will be much diminished by contraction, or that it may be closed subsequently. If the disease has extended up the recto-vaginal septum, the peritonæum must be looked out for, and the greatest care taken not to open this cavity at the upper part of the dissection. If this should occur, an aseptic sponge must be kept over the opening. The levator ani being carefully cut through, the rectum, now separated everywhere save above, is dragged down by an assistant or by the operator with his left hand. While this tension is kept up, the surgeon with his finger, aided by scissors, frees the bowel sufficiently above the disease to admit of dividing it safely. Frequent examination of the interior of the bowel should be made at this stage to tell when the upper limit of the disease has been reached. The rectum should be divided at least an inch above this point. Before the bowel is cut away, the upper end should be secured

FIG. 163.



(Allingham.)

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* Subsequent sloughing here is not unlikely.

with a vulsellum, for fear that it may retract and carry any still bleeding points out of reach.

When the bowel has been safely isolated above the disease, it must be divided either with the wire loop of an écraseur, as recommended by Mr. Cripps, or by scissors. When the patient is in good condition, where little blood has been lost, and where the operation has not been much prolonged, division by scissors is to be recommended, as these give a much cleaner-cut surface, and one therefore less liable to slough, and they furthermore avoid the risk which is inseparable from the use of the écraseur—viz., its gradually encroaching, as it is tightened, more and more closely upon the diseased area.

If the surgeon is unprovided with an écraseur, he may divide the rectum with a Paquelin's cautery. But, as remarked by Mr. Cripps, the use of any form of cautery during the operation makes it exceedingly difficult to distinguish between the hard nodules of burnt tissue and portions of the disease which may be left behind.

The bowel having been removed, all bleeding points * are most carefully looked for, and the wound is thoroughly dusted over with iodoform, painted over with this antiseptic and ether,† and lightly plugged with strips of aseptic gauze.‡

If the peritonæum has been injured and the opening is too large for suturing, either a drainage-tube packed around with gauze, or a tampon of gauze, must be made use of.

Mr. Cripps considers that any attempt to bring down the edges of the cut rectum, and to stitch them *in situ* around the anus, is perfectly useless, as the sutures are certain to cut their way out, and harmful, as likely to prevent the escape of discharges. As this entails the very serious risk of septicæmia, the advantage which suturing the bowel would give, if it were safe, of preventing subsequent contraction (p. 1010) must be put aside.

Question of Partial Removal.—If any of the mucous membrane, even a mere strip, can be *safely* left, the amount of subsequent contraction will be less; but here, as in all other operations for malignant disease, every consideration must give way to the chief object, that of extirpating the growth.

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* If the patient's strength fail towards the close of the operation, no time should be lost in tying the vessels, but each bleeding point should be secured with Spencer Wells' forceps, to be removed in twenty-four or thirty-six hours.

† Throughout the operation the wound should be well syringed with a solution of mercury perchloride (1 in 2000). This should be used very hot, if there is troublesome oozing.

‡ If it is necessary to do this firmly, the plugs should be removed, by soaking, as soon as possible, in order to allow of escape of discharges.

Partial operations should be reserved only for cases where the disease is very localized in amount, and admits of extirpation, together with a very wide margin of bowel. Where the disease implicates one-half of the bowel, even if apparently not disseminated in the mucous membrane, the whole circumference should be removed. Mr. Allingham thus condemns partial operations: "The partial removal of the circumference of the bowel is, in my opinion, most unsatisfactory. In all the cases in which I have removed only part of the wall there has been either a return of the disease in the rectum, or in the glands in the groin, or in some internal organ, mostly the liver."

If the surgeon decide on a partial operation, he must be prepared for some increased difficulty owing to the diminished room for working, and meeting the hæmorrhage. Perhaps only one semilunar incision around the anus will be required. Mr. Cripps thus advises the use of the écraseur:—"A strong, blunt-pointed, slightly curved needle, 4 inches in length, armed with strong string, is then thrust in at the upper angle of the curved lateral incision, at a point opposite the posterior preliminary incision, or further round if the disease has encroached at all on the anterior wall. The needle is made to traverse the tissues external to the muscular coat of the bowel to a sufficient height, and the point, guided by the finger in the rectum, is thrust through the coats into the cavity of the bowel. The loop of string thus passed through is seized and drawn out of the anus, while the needle is withdrawn through the hole at which it entered. By means of this loop one end of an écraseur wire is drawn back into the bowel and out again at the puncture made by the needle. This, together with the other end of the wire which hangs out of the rectum, are fixed to the écraseur, and the intervening tissues cut through. The strip of bowel between the posterior incision and the one just made by the écraseur can now be separated by the finger from its lateral connections, the separation, of course, commencing from the semilunar incision round the anus. In this way the rectangular flap of bowel in which the disease is situated is detached from the surrounding connections, except at its upper margin. It is then drawn down and cut off by the écraseur or scissors. It can be readily understood how the steps of this operation must depend upon the portion of bowel in which the disease is situated. If this be in the middle line behind, the disease, or a portion of it, will probably have been split by the first incision, in which case a strip of bowel must be removed on either side; or again, if it be on the anterior wall, the écraseur wire will have to be twice passed by the thread and needle, once on each side of the disease." For the reasons given above (p. 1014) scissors are much to be preferred to the écraseur.

After-treatment.—The chief points here are to keep the wound sweet by frequent syringing with dilute mercury perchloride solutions, or Condy's fluid, and the insufflation of iodoform. The catheter will probably be required, and a mild aperient may be given about the sixth day, if needed. The finger should be occasionally passed with the utmost gentleness, and after a week or ten days, a tallow candle, succeeded later by a bougie, or the vulcanite tube (p. 1011).

Question of Colotomy before Excision of the Rectum.—Theoretically, this preliminary step would seem very advisable, as diverting the fæces, and thus a source of decomposition, and as doing away with the need of the use of bougies to prevent contraction (Haslam, *St. Thomas's Hosp. Reports*, vol. xviii. p. 151). From a practical point of view, I do not think a preliminary colotomy advisable. It wastes precious time, and entails two operations in patients too often with poor vitality and too little power of repair. Finally, the results of excision of the rectum, especially those of Mr. Cripps and Mr. Allingham, show that this preliminary is not needed.

High Excision of the Rectum with Partial Removal of the Sacrum.—I have not described this method, which has found favour with some German surgeons, as I believe it to be quite unsuited for the patients who come before us with rectal cancer. It is an extremely severe operation, and uncertain at the best. A summary of Dr. Kraske's paper (*Arch. f. Klin. Chir.*, 1886, Bd. xxxiii. S. 563) will be found in Mr. Butlin's *Operative Surgery of Malignant Disease*, p. 246.

Causes of Trouble and Failure after Excision of the Rectum.

1. Shock. 2. Hæmorrhage. This will rarely be difficult to deal with at the time, or met with later, if the surgeon has plenty of Spencer Wells' forceps, good assistants, and, if he does the operation steadily, controlling each vessel as met with.* This, aided by hot injections (p. 1014) and firm sponge pressure, will usually prevent any secondary hæmorrhage. If this should occur, Prof. Macleod's advice should be followed—viz., to pass a large

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* Mr. Cripps has shown that, as most of the bleeding comes from vessels situated in the walls of the rectum, dragging down the bowel with a firm grasp will not only greatly facilitate the operation, but also prevent hæmorrhage.

tube into the bowel for the escape of flatus, &c., and to pack carbolized sponges, or strips of gauze, firmly round this. 3. Suppuration. Cellulitis and other septic troubles. 4. Peritonitis. 5. Exhaustion. 6. Recurrence.

IMPERFORATE ANUS.—ATRESIA ANI.—IMPERFECTLY DEVELOPED RECTUM (Figs. 164–170).

A surgeon, when called upon to explore these cases, will do well to bear in mind the following natural and practical classification, because on this depends his treatment:—

Two Main Varieties:—

A. Cases in which no normal anus exists—*Imperforate Anus.*

B. Cases in which a normal anus exists, but the gut is obstructed higher up, or undeveloped—*Imperforate Rectum.*

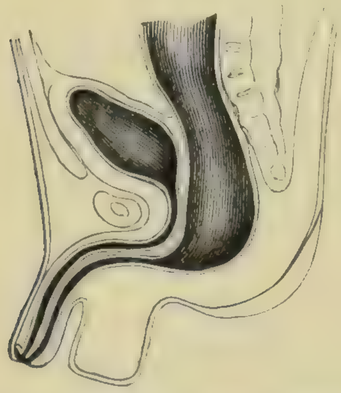
A. *Imperforate Anus.*

1. Anus partially closed—(*a*) by adhesions of epithelial surfaces, as occasionally happens in the labia of a female infant; (*b*) by a membrane.

2. Anus completely closed, but only by a membrane.

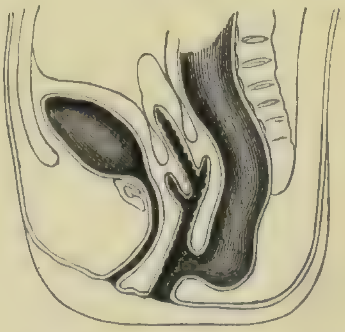
3. Anus completely closed by a membrane, but a fistula exists —(*a*) on the surface of the body (*e.g.*, the raphé of the scrotum); (*b*) into the vagina, Fig. 165; (*c*) into the urethra or bladder, Figs. 166, 170.

FIG. 164.*



Anus absent. Rectum opening by fistula, close to urethra. (Rushton Parker.)

FIG. 165.



Anus absent. Rectum communicating with vagina. (Rushton Parker.)

4. Anus imperforate and the rectum deficient as well.

B. Anus in natural position, but the rectum is deficient†—

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[*] This, and the next six figures, are taken (with a few alterations) from an article by Mr. Rushton Parker (*Liverpool Med. Chron.*, July 1883).

[†] As Mr. Holmes has shown, these cases are important, as they are liable to be overlooked till considerable distension has taken place.

(*a*) the rectum is deficient for a short distance only, and separated from the anus by a cul-de-sac, Fig. 168; (*b*) the rectum is deficient for a long distance, or entirely, Fig. 169.

Treatment.

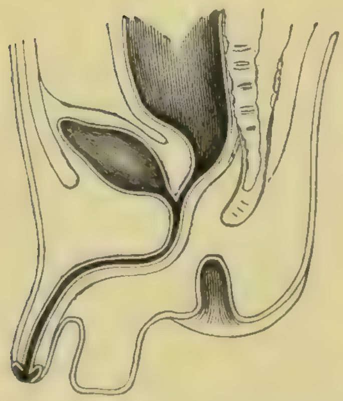
A. Those in which no natural anus exists.

1 and 2. If the atresia be due to epithelial adhesions, or to a more or less complete membrane, the former should be broken down and the latter snipped away with scissors, and the opening kept patent by a small piece of oiled lint, the nurse's little finger being introduced twice daily.

3. If the anus be imperforate, and a fistula open (*a*) on the surface of the body, (*b*) into the vagina, or (*c*) urethra.

(*a*) A probe is passed from the skin-fistula (*e.g.*, in the scrotum) towards the proper anal site; it is then cut down upon and the opening established in the proper position.

FIG. 166.



Anus ending in cul-de-sac. Rectum opening into urethra far back. A case for Littré's operation. (Rushton Parker.)

(*b*) If the fistula open into the vagina, the treatment will vary somewhat with the urgency of the case, the size of the opening, and the age of the child.

Thus, if the opening be very small and the retention urgent, a silver director should be passed through the vaginal fistula back to the proper site of the anus, and there cut down upon. If the bowel is within reach, it should be drawn down and stitched *in situ*. The orifice should be kept patent.*

If, owing to the size of the vaginal fistula, there is not much retention, and especially if the child be not very young, the following operation may be performed, after the method of Rizzoli (quoted by Mr. Holmes, *Syst. of Surg.*, vol. iii. p. 788):—An incision is made from the vulva to the coccyx in the middle line, the rectum found by most careful dissection, separated from the vagina, and then brought down and fixed in its natural position. To aid in finding the rectum, a probe will be passed from the fistula.

After the rectum has been brought down and secured, the incision between the anus and vulva is united to form a new perinæum.

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* In such a case, though an anus is established in the proper position, it is very doubtful if the vaginal fistula will close, and a further operation will probably be required later on. Plastic operations should not be tried too early on account of the softness of the tissues and the liquid condition of the fæces.

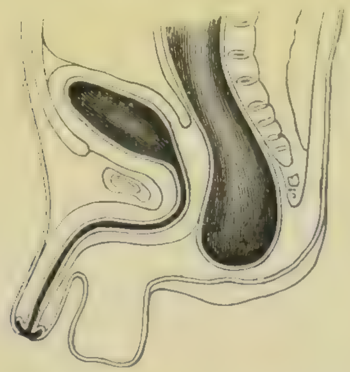
(*c*) Fistula into the urethra or bladder. Two questions here arise, How high up is the communication? How much of the bowel is deficient?

If the perinæum seem fairly developed, if the ischial tuberosities are not in close contact, if any bulging can be detected at the natural site of the anus, the communication is probably recto-urethral, and an attempt may reasonably be made to find the bowel from the perinæum. If it is found, and can be brought down, an attempt may be made to separate it from the adjacent urethra, but usually the surgeon will have to be satisfied with a free opening, and with keeping this patent, so as to encourage the urethral communication to close. If there appear no probability of the bowel being within reach, or if this cannot be found, Littré's operation should be performed (p. 693).*

4. Anus absent and rectum deficient as well. Here the chief question is how far upwards an exploratory operation may be safely conducted.

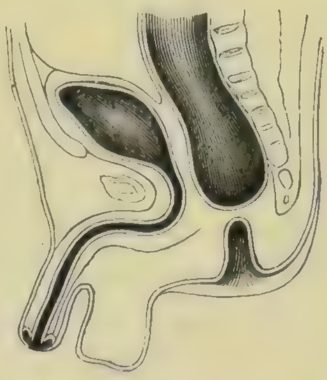
External evidence. Genitals far back and close to the coccyx, and ischial tuberosities close together, point to absence of the rectum.

FIG. 167.



Anus absent. Rectum could be reached by dissection. (Rushton Parker.)

FIG. 168.



Anus ending in cul-de-sac. Rectum readily reached from this. (Rushton Parker.)

In most cases the surgeon begins by exploring. The child being under ether and in lithotomy position, with a small sandbag under the sacrum,† the surgeon, seated at a comfortable level, makes a free incision from the position of the anus back to the coccyx. Keeping exactly in the middle line, and opening up the cellular tissue with his finger-tip, aided by a scalpel and director, the surgeon works backwards towards the concavity of the sacrum, constantly taking note with his finger-tip of the depth to which he has got, while an assistant aids in bringing down the bowel by supra-pubic pressure.

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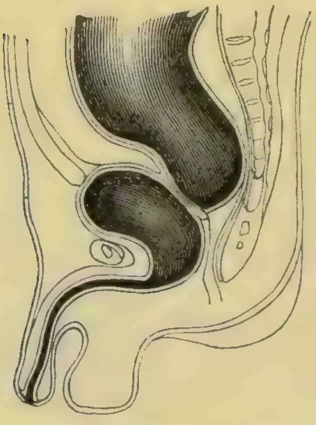
* If the child survive, the bladder must be kept carefully washed out if any fæces still find their way into it. Thus, in a case of Mr. Clutton's (*St. Thomas's Hosp. Reports*, vol. xi. p. 84), a child about a month old died, sixteen days after Littré's operation, of suppurating kidneys, due to the offensive purulent urine.

† The bladder may first be emptied with a catheter.

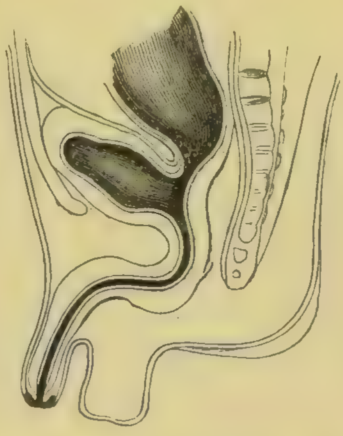
As a rule, 2 inches are a sufficient depth in a new-born child. If still in doubt whether to proceed or no, the surgeon may make a careful puncture with a morphia-syringe backwards, and note the condition of the point; no puncture with a trocar is justifiable at this depth.

FIG. 169.



Anus absent. Rectum ending high up. A case for Littré's operation. (Rushton Parker.)

FIG. 170.



Anus and rectum deficient, the bowel ending in the bladder. (Rushton Parker.)

Points to bear in mind.—1. The rectum may end at the brim of the pelvis. 2. If it end lower down, it may be floating with a long meso-rectum. 3. Though the rectum may end within reach, the peritonæum may, and not unfrequently does, extend low down on the bowel. 4. Even if the rectum is successfully opened high up, without opening the peritonæum, fatal cellulitis may be set up by the escaping fæces, or by the attempts to keep the bowel patent.

If the above exploratory operation fail, inguinal colotomy or Littré's operation should be resorted to, p. 693.

B. *Imperforate Rectum.*—The treatment here will be an exploratory operation (p. 1019), followed, in case of failure, by Littré's operation (p. 693).

CHAPTER XVII.

RUPTURED PERINÆUM (Figs. 171, 172).

THE following account is taken from my colleague, Dr. Galabin:*

A. **Operation for Partial Rupture** (Fig. 171).—" The patient is placed in lithotomy position. The need for assistants to support the thighs is avoided if ' Clover's crutch ' is used. By this the thighs, just above the knees, are fixed by circlet straps at the end of an iron bar, the length of which can be regulated by a screw which fixes it in any position. The thighs are then flexed to any required degree by a padded strap which passes from one end of the bar round the neck, and is then attached to the other end. Thus, the knees can be kept widely apart while the operation is performed, and brought closer together by altering the screw, when the time arrives for tightening the sutures.

" The extent of surface to be freshened is indicated, to some extent, by the cicatrix left by the rupture. It is well, however, to go a little beyond the limits of this in all directions, especially up the median line of the vagina and towards the lower halves of the labia majora, both in order to secure, if possible, a perinæal body somewhat larger and deeper than the original one, and to allow some margin, in case the surfaces do not unite completely up to the edges. To put the mucous membrane on a stretch, an assistant at each side places one or two fingers on the skin of the thigh and draws the vulva outwards (Fig. 171). The skin just beneath A, in front of the anus, may also be seized by a tenaculum and drawn downwards. If still the mucous membrane is not sufficiently on the stretch, from laxity of the vagina, the posterior vaginal wall, some distance above B, should be seized by long-handled tenaculum-forceps and pushed upwards. Incisions are then made through the mucous membrane from B to A, in the median line of the vagina, and from A to C and D through the junction of mucous membrane and skin. These should not be extended in the direction of C and D further than the lower extremity of the nymphæ at the utmost. There are then two triangular flaps, ABC and ABD. These are to be dissected up from the apex A towards the base BC and BD, the corner of the mucous membrane at A being seized with dissecting forceps. The dissection should not be deeper than necessary, and if it is done with the knife the surfaces are more ready to unite. If, however, there is much tendency to bleed, scissors may be used. The apices of the flaps are then cut off with scissors, leaving an upturned border along BC and BD. When the surfaces are drawn together these borders form a slightly elevated ridge towards the vagina, and if there is any failure of union just along the edge they fall over and cover it.

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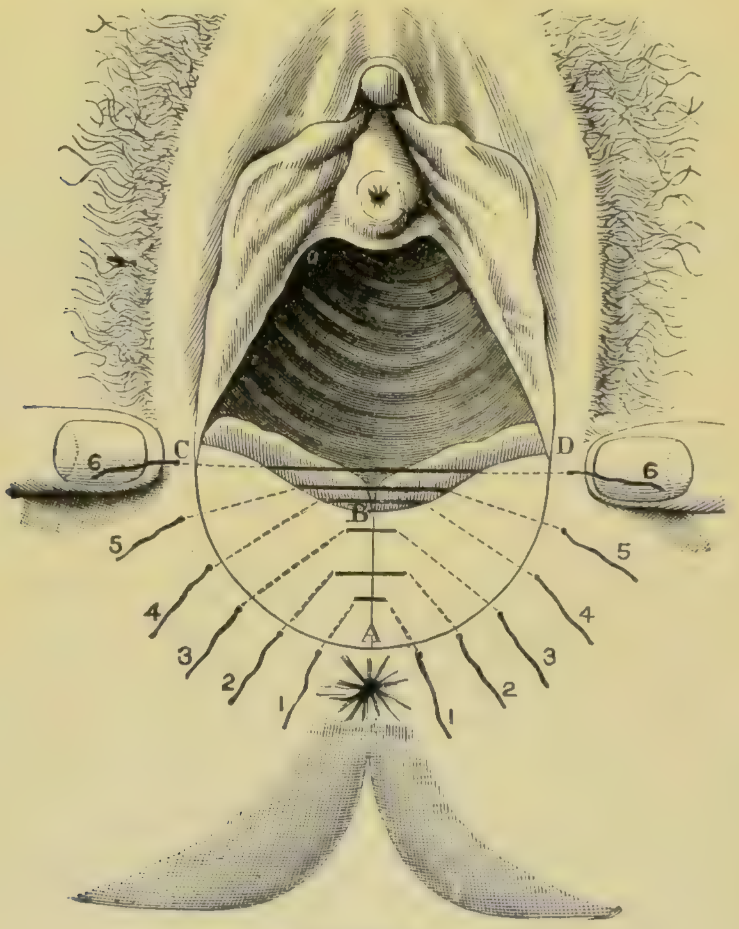
* *Dis. of Women*, pp. 130, 381. Any one making trial of this method will agree with me as to its simplicity and excellent results.

FIG. 171.



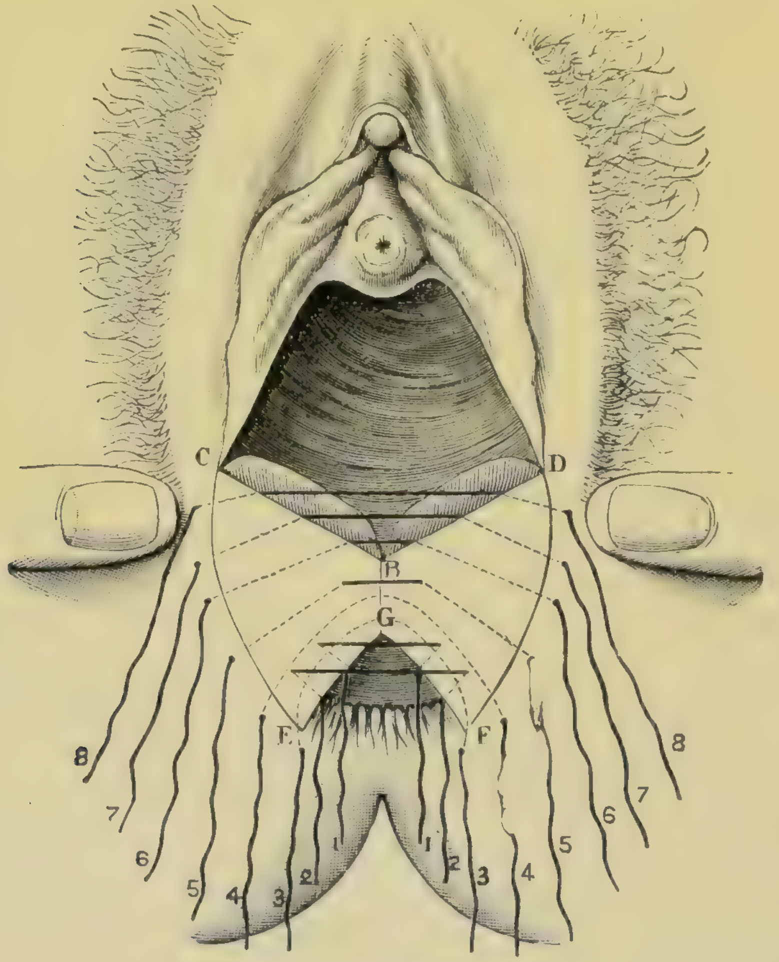
(Galabin.)

"The best material for sutures is the silkworm- or fishing-gut, which should be stout, of the thickness used for salmon flies. It may be stained with magenta, to render it more easily visible. This has all the advantage of silver wire, as being non-absorbent, while, at the same time, it is easier to manipulate, and the exposed ends do not cause discomfort after the operation, like those of wire. The sutures are placed as shown in the figure. The most convenient needle is a slightly curved one, not too thick, mounted in a handle. This is passed in, unthreaded, rather close to the edge of skin, brought out on the raw surface, then threaded with the end of the suture, which is so drawn through. By passing the needle in the same way on the other side, the other end of the suture is drawn through. Another mode is to use a more curved needle, and to bury the sutures, 1, 2, and 3, in the tissues throughout their whole course. If, however, they are brought out in the centre for spaces alternately short and long (Fig. 171), the surfaces are more easily brought into contact at all levels without undue tension. In passing sutures 4, 5, 6, the needle should be brought out precisely on the margin along which the border of mucous membrane BC, BD, are turned up from the vagina, not passing through the mucous membrane itself. The sutures are then tied in the order of the numbers from 1 to 6, care being taken that the surfaces are brought just sufficiently into apposition, and that no clots or blood are left between them. The bleeding, if any continues, is arrested by bringing the surfaces together, and if they are properly united there will be no secondary hæmorrhage, unless the sutures begin to cut from excessive tension. The sutures may be left in from seven to ten days."

Operation for Complete Rupture (Fig. 172).—The preliminary steps are taken as above. " A point B in the median line of the vagina, a sufficient distance above the apex of the rent in the septum, is taken, and an incision through the mucous membrane is made from B to G, and from G to E and F along the edges of the septum, between the rectal mucous membrane and the cicatrix. Incisions are also made through the skin from E to C and F to D, so that the freshened surface may extend somewhat beyond the limits of the cicatrix, C or D not to be higher than the lower extremities of the nymphæ. The quadrilateral flap EGBC is then seized at E by dissecting forceps, and dissected up with the knife from the angle E, and afterwards from the angle G, towards the base BC. While this is done, the parts are kept on the stretch by an assistant drawing down the skin below E with a tenaculum. The flap is then cut away with scissors, except an upturned border, which is left along BC. The flap FGBD is treated in a similar manner. If, as is usual, the ends of the sphincter at E and F have retracted from the margin of the cicatrix, it is well to cut away with the scissors a narrow strip of rectal mucous membrane, generally somewhat everted, a short distance from E and F towards G, so as to bring the freshened surface to the ends of the sphincter.

"Sutures of silkworm-gut are then applied in the following manner:—First, rectal sutures, either two or three, according to the extent of the rent in the septum, are applied. These are destined to be tied in the rectum, and the ends left projecting through the anus. They are best applied with a half-curved needle, held in a holder. The needle is passed in a little distance from the margin of the rent, and brought out almost at the very edge of the rectal mucous membrane, on the line GF. The needle is then threaded at the other end of the suture, and that is drawn through in the same way from without inwards, on the margin EG. Next two sutures at least are passed completely round through the remnant of the septum, by means of a curved needle, not too large, mounted in a handle. This is passed unthreaded, and draws the suture back with it on withdrawal. The first of these (3, Fig. 172) is passed in somewhat behind and below the angle F, so as to take up, if possible, or at least go quite close to, the end of the

FIG. 172.



(Galabin.)

divided sphincter, and is brought out in a similar position near E. Thus, when tightened, it brings together the ends of the sphincter, drawing it into a circle; but it often brings into apposition, not so much the freshened surfaces above as the unfreshened rectal mucous membrane. This serves as a barrier to keep out fæcal matter, while the next suture (4, Fig. 172) aids the rectal sutures in uniting the freshened surfaces. The remaining sutures are passed as shown in the figure (5–8, Fig. 172) by a slightly curved needle mounted in a handle, in the same way as in the operation for incomplete rupture (Fig. 172). The needle, unthreaded, is passed in pretty close to the edge CE or FD, is brought out (except in the case of suture 5, Fig. 172) on the line where the margin CB or DB is turned up, and draws one end of the suture back with it, the other end being afterwards drawn through in the same way. The effect is, that when the sutures are tightened, the margins BC, BD are turned up into a slight ridge towards the vagina, and afterwards fall over and cover any portion of the vaginal border which does not unite quite up to the edge. Suture 5 (Fig. 172) may either be buried throughout, or brought out for a very short space near the median line BG.

When all the sutures are in place, the sponge* is withdrawn from the rectum, and the rectal sutures are tied first. Care must be taken to draw up the whole of the slack in the centre, and bring the edges EG, FG perfectly together. This will approximate the ends of the sphincter to a great extent, and the approximation is completed by tightening suture 3. The remaining sutures are then tied in the order of the numbers, care being taken to allow no clots or blood to remain between, and to tighten them just enough to bring the surfaces in contact. The ends of the rectal sutures may be left moderately long, to distinguish them, the rest cut pretty short.

The perinæal sutures are removed in seven days. The rectal sutures may be left from ten to fourteen days longer, till the perinæum is consolidated. They are then removed through a small rectal speculum, care being taken not to break down any of the union in passing it. By this operation the anus is generally much more completely restored than by the use of quilled sutures, or the plan of making deep lateral incisions to relieve tension. If there is much resistance to bringing the surfaces together, the only thing required is to use more numerous sutures, so as to diminish the tension on each.

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* This, secured with tape, is introduced into the bowel, to prevent the descent of any fæces left by an enema.

In some cases, by the primary operation after labour, only superficial union is secured, and a recto-vaginal fistula is left close to the part united. The best plan is then to cut through the bridge of union with scissors at the time of the operation, and then proceed as in the case of complete rupture. This is the only way to secure a firm and thick perinæum, and is less likely to fail than an operation on the fistula alone."

PART V.

OPERATIONS ON THE LOWER EXTREMITY.

CHAPTER I.

OPERATIONS ON THE HIP-JOINT.

AMPUTATION AT THE HIP-JOINT.—EXCISION OF THE HIP-JOINT.

AMPUTATION AT THE HIP-JOINT (Figs. 173–179).

THIS formidable operation has been much simplified of late years by the most important improvement of Mr. Furneaux Jordan,* whose method should replace all others in every possible case. It will be described first here, and a few of the other methods, sufficient for all practical purposes, will be given afterwards.

Methods.—I. **Furneaux Jordan.** II. **Antero-posterior Flaps.** III. **Lateral Flaps.** IV. **Modified Lateral—viz., Antero-internal and Postero-external—Flaps.**

I. **Furneaux Jordan's Method** (Fig. 174).—By amputating through the thigh as low down as possible, and shelling out and disarticulating the femur, it is now possible to avoid, in large measure, these dangers which were formerly inseparable from the operation—viz.: 1. Shock, the limb being removed much farther from the trunk. 2. Hæmorrhage. *a.* Abundant room is afforded for compression of the common femoral, and the vessels behind. *b.* The large vessels can easily be secured on the face of the stump. *c.* The gluteal and sciatic arteries remain untouched, the hæmorrhage from these, in the older operations, being a source of serious danger. 3. Septic changes. By the other methods, the copious discharge of bloody serum from the large wound,* being poured out close to the anus and genitals, was very liable to decompose. By this operation, both the end of the stump and the wound on the outer side can be more easily drained and kept aseptic. In making use of this amputation, especially for hip disease or failed excision, the surgeon should not attempt too much to secure primary union.† 4. The stump is a better one. It is longer, more mobile, and occasionally, as in amputation for acute periostitis or necrosis, it is possible to preserve much of the periosteum from the upper half of the femur, and a cord‡ will be left which will render the stump movable. Whether in any case an artificial limb can be worn for more than about half an hour at a time is very doubtful.

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* Dr. W. F. Arnold, assistant-surgeon U.S. Navy, has kindly drawn my attention to the fact that an amputation, in all essentials the same as Furneaux Jordan's, was performed as long ago as 1806 by Dr. W. Brashear in Bardstown, Kentucky. The following account, taken from a letter by Dr. Brashear, will be found in Dr. Mott's edition of Velpeau's Surgery, in a summary of hip-joint amputations by Dr. Eve, of Tennessee. The patient was a lad, aged seventeen. An operation on the thigh in the ordinary manner was determined upon, as remote from the hip-joint as circumstances might justify (in this case, about mid-thigh). The amputation was performed and the arteries secured. The next step was to make an incision from the lower end of the bone externally over the great trochanter, to the head of the bone and upper part of the socket. The dissection of the bone from the surrounding muscles was simple and safe, by keeping the edge of the knife resting against it. The bone being disengaged from its integuments at its lower extremity, was then turned out at a right angle from the body, so as to give every facility in the operation to separate the capsular ligament and remove the head from its socket. The patient made a good recovery. Judging from a letter from Prof. Ollier to Mr. Shuter (*loc. infra cit.*) the former surgeon had recommended this method in 1859, and performed such an operation once.

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* As will be shown below, the wound in a Furneaux Jordan amputation is also a large one, but much more happily placed for being drained and kept sweet.

† Verneuil (*Paris Acad. de Méd.*, 1877).

‡ The committee of the Clinical Society appointed to examine Mr. Shuter's case of sub-periosteal amputation of the hip-joint reported (*Trans.*, vol. xvi. p. 89), (1) that, though there was a firm, resisting cord of considerable size in the centre, which afforded the muscles a common point of attachment, there was not sufficient evidence to enable them to state that this cord contained bone; (2) that the muscles were in a high state of nutrition, the patient not only powerfully flexing, extending, abducting, and adducting his stump, but being able to communicate all these movements to the artificial limb.

Mr. Shuter in his paper (*loc. supra cit.*) says that his patient was able to wear an artificial limb "for some hours nearly every day for a period of about five months. I then forbad his wearing it for a time on account of a tender sinus which opened opposite to the acetabulum. In the notes of this case, quoted by Mr. Holden in his obituary notice of Mr. Shuter (*St. Barthol. Hosp. Reports*, vol. xix. p. 38), it is stated that "the stump was sufficient to enable the patient to wear an artificial limb for a time, but he was obliged to leave it off on account of its weight." I have now performed this amputation seven times. Six recovered, and, in one of my three cases in adults, a delicate girl of twenty has been able to wear a very light limb, made by Messrs. Maw and Thompson, for three hours at a time. In such cases as these, where the patient is much reduced by long-standing hip disease, and the periosteum is still adherent to the wasted femur, it is not, in my opinion, advisable to spend time in stripping it off. While the shock of the hip-joint amputation is much lessened by this method, it cannot, of course, be entirely removed.

Methods of Controlling Hæmorrhage during Amputation at the Hip.

1. *Elastic Compression by Jordan Lloyd's Method* (Fig. 174).—This may be applied at the junction of the limb and trunk, without interfering with the operator, by the following method :—When the patient is passing under the anæsthetic, the limb is emptied of blood by elevation and application of Esmarch's bandages as far up as the tissues are healthy ; the patient is then rolled over on to his sound side, and a piece of rubber bandage about 2 yards long, and stout enough to require decided exertion to stretch it out fully, is doubled and passed between the thigh and trunk, its centre lying between the anus and tuber ischii. A white bandage of appropriate size is then laid over the termination of the external iliac artery. The ends of the rubber bandage are now to be firmly and steadily drawn in a direction upwards and outwards, one in front of the groin and one over the buttock, to a point above the centre of the iliac crest, sufficient tightness being employed to stop all pulsation in the femorals or tibials. The front part of the band passing over the white bandage occludes the external iliac and runs parallel to and above Poupart's ligament. The posterior part runs across the great sacro-sciatic notch and controls the branches of the internal iliac. If the surgeon is short-handed, instead of the cords being held by an assistant, they may, by means of tapes strongly stitched to them, be thus secured : When drawn with full tightness up to the centre of the iliac crest, they may be crossed over to the opposite side and tied firmly (over lint) midway between the crest and the top of the great trochanter. If a strong and trusty assistant is forthcoming, it will be better to leave the bandage in his hands, but in the case of an adult whose tissues are not wasted, and on a hot day, the exertion is not a slight one.*

Whether the bandage be held or tied, especial care must be taken that it does not slip from off the external iliac nor over the tuber ischii. It is a good plan to pass the ends of the india-rubber band over a slip of wood, so as to diminish the prolonged pressure on the hands. To prevent the bands slipping down in the way of the surgeon, two loops of tape or bandage may be thus employed : Each, about 2 feet in length, is placed longitudinally, before the elastic band is applied, the one over the groin, the other well behind the great trochanter, the centre of each being where the elastic band will go. When the band has been applied, these form loops by means of which the band is kept well out of the operator's way, both at Poupart's ligament and behind the great trochanter (Jordan Lloyd, *Lancet*, 1883, vol. i. p. 897).

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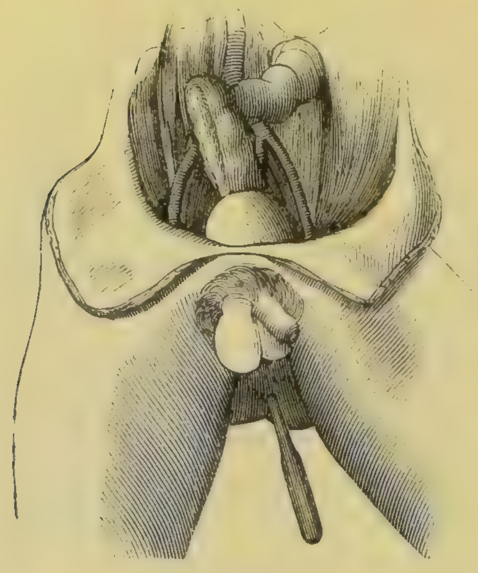
* As will be seen from the description of the operation below, this exertion is only required during shelling out of the femur, a step often simplified by a previous excision. During the circular amputation in the lower third of the thigh, and the securing the large vessels here, there is abundant room to control these by an Esmarch's bandage applied in the usual way.

2. *Davy's Lever* (Fig. 173).—This ingenious instrument, introduced by Mr. Davy, of the Westminster Hospital, consists of a smoothly turned rod of ebony-wood or metal, from 18 to 22 inches long, with the rectal end enlarged, bluntly conical and most carefully polished and graduated, and the other forming the handle.

FIG. 173.



(After Davy.)

Oil being thrown into the bowel, the rectal end is introduced, directed towards the vessel to be compressed, and felt for over the situation of the artery through the abdominal wall. Thus, if the right external or common iliac is to be compressed, the handle is lowered and carried over close to the adductors on the left side, so that its end drops over the artery on the pelvic brim (Fig. 173).

Mr. Davy* claims for his instrument the following *advantages*:—(*a*) More perfect control of both external and internal iliacs. (*b*) It inflicts a minimum amount of disturbance on the respiratory movements and the circulatory system. (*c*) It is generally and easily applicable. A strictured rectum is the sole obstacle. [So also would be a short and tight meso-rectum.] (*d*) The pressure applied is easily maintained, while the assistant in charge of the lever is out of the way of the operator. (*e*) Its application is quite safe in skilled hands, no injury having ever resulted, and but little pain having been suffered. (*f*) It is cheap and simple. (*g*) It has been successful. Mr. Davy, in his paper above quoted, had records of ten cases in which the lever had been employed; the total amount of blood lost during the ten operations had been under 18 oz., and there had been 80 per cent. of recoveries.

Disadvantages.—Simple and ingenious as the above method is, it is beyond doubt that it has caused a fatal result from injury to the peritonæal coat of the rectum. It is now likely to be replaced by the Furneaux Jordan method. On account of the above risk I prefer to meet the hæmorrhage either by the above-mentioned method, or, where this is impossible, by securing the vessels before they are cut (p. 1036). 3. Compressing the common femoral or the termination of the external iliac by the fingers or hands, aided, if need be, by a weight. This is only possible in the case of a child, and the assistant thus employed is liable to be in the way of the operator. 4. Lister's Tourniquet.—This means of compressing the termination of the abdominal aorta is not a light matter, apart from the very grave operation into which it enters. This is owing to the difficulty of making sure of avoiding such important structures as the duodenum, pancreas, solar plexus, and small intestines, and to its interference with respiration and circulation. 5. Commanding the main artery during the operation either by seizing a flap (Figs. 176, 177) or by securing the vessels before they are divided (p. 1036).

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* *Brit. Med. Journ.* 1879. vol. ii. p. 685.

Furneaux Jordan's Operation[*] (Fig. 174).—The vessels in front and behind being commanded in the manner given at p. 1029,[†] the patient's pelvis is brought to the edge of the table and his body rolled a little on to the sound side, the surgeon standing usually to the right of the diseased limb—*i.e.*, inside on the left and outside on the right side—draws up the soft parts forcibly with his left hand, and makes a circular incision through the lower third of the thigh, using his knife as at p. 91, the assistant who is in charge of the limb rotating it so as to make the tissues meet the knife. A circular cuff-like flap of skin and fasciæ is then quickly raised for about 2½ inches,[‡] an assistant, who stands opposite the surgeon, giving much help hereby, seizing and everting the cut edge of the flap, as the surgeon raises it. The flap being drawn upwards out of the way, the soft parts are severed by one or two vigorous circular sweeps down to the bone, and the large vessels and any others that can be seen are next secured. Pressure* is now made with sponges wrung out of carbolic-acid lotion on the still oozing wound, and the patient being now rolled well over on to his sound side the surgeon cuts along the outer side of the thigh, starting from the circular wound and ending about midway between the iliac crest and top of the great trochanter. This incision goes straight down to the bone and runs into any excision wound, or sinuses which may exist over the joint. The soft parts are then rapidly stripped off the femur, partly with the knife, partly with the finger, the only difficulty met with being along the linea aspera. If an excision has been performed, the operation is rapidly completed, but if the head and neck remain intact, the final steps will be rendered more difficult, and the joint must be opened from the outside by cutting strongly on the neck of the bone, this being facilitated by the assistant moving the limb in accordance with the surgeon's directions, as different parts require to be put on the stretch, rotation of the femur strongly outwards, and dragging of the head away from the acetabulum being required at the last.

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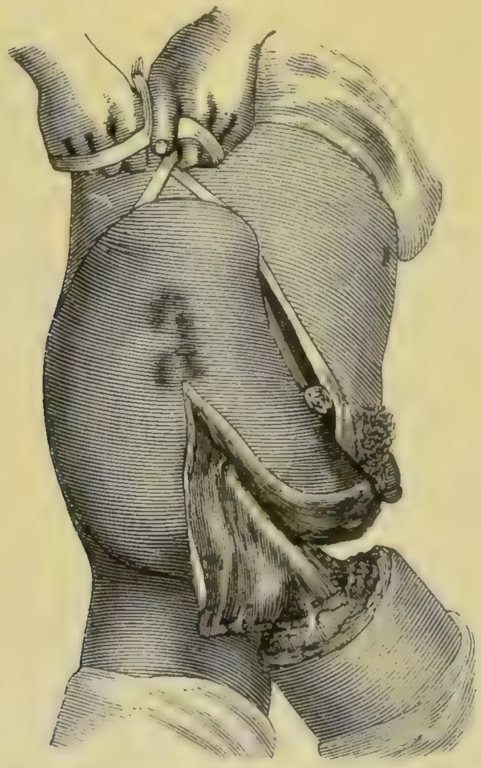
[*] Every provision must be taken against shock. The limbs should be bandaged in cotton-wool, the body well wrapped up, the head kept low, ether given, nutrient injections kept at hand, and subcutaneous injections of brandy or ether given from time to time. The spray should be dispensed with, and the wound syringed from time to time with mercury perchloride solution (1 in 2000).

[†] Before commencing the circular amputation, a little above the knee, I have the limb elevated, an Esmarch bandage applied up to the knee, the thigh emptied of venous blood by firm stroking, and a second Esmarch bandage then applied firmly just below the trochanters, and the lower one removed. The india-rubber band (p. 1029) is also placed, lightly, ready *in situ*. The circular amputation is then performed, and the large vessels secured. The upper Esmarch is next removed, and the india-rubber bandage firmly tightened while the femur is shelled out or, perhaps, disarticulated.

[‡] The surgeon need not trouble to raise a larger circular flap. As the femur is removed, the muscles lose their fixed point to contract from, and are thus easily covered.

FIG. 174.



Furneaux Jordan's amputation. Above is shown the means of controlling hæmorrhage described at p. 1028. Lower down are seen the sinuses of an unhealed excision, and the method of shelling out of the femur, after a circular amputation has been performed, and the large vessels secured.

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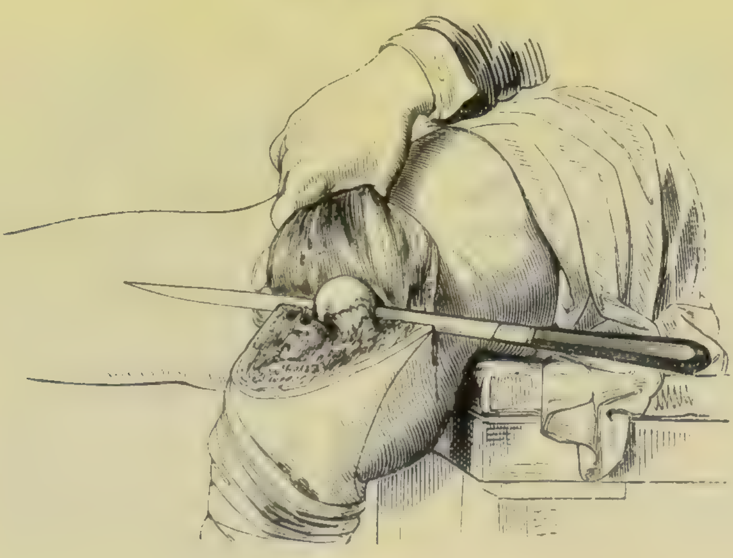
* Valuable time should not be wasted in trying to secure every bleeding-point, either now or later. See foot-note, p. 1033.

Free drainage must be provided, for it must be remembered that the wound left by this method is a very large one, though it has the advantage of being farther removed from sources of sepsis. Thus, especially if the tissues are riddled with sinuses, too much of the wound must not be closed, and, if shock is present,* the surgeon must not wait to insert many sutures, but, trusting to firm bandages over an aseptic dressing, get his patient quickly back to bed. If disease of the acetabulum be present, the surgeon will, if the patient's condition admit of it, attend to this, the insertion of a drainage-tube through this bone being specially required if pelvic suppuration be present.

Amputation by different Flap Methods.—The following will be given here, it being understood that in no case can any of them be recommended if Furneaux Jordan's method is available.

II. **Antero-posterior Flaps** (Figs. 175–178). **Methods of Guthrie and Liston.**—The patient being prepared against shock (p. 1031), and the main vessels secured by one of the methods already given, the limb being brought over the table and supported in the semi-flexed position by an assistant, while the opposite limb is secured over the table by a bandage, the surgeon standing outside the left and inside the right limb, raises the

FIG. 175.†



(Fergusson.)

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* In some cases this is so from the beginning of the operation. This was most markedly the case in one of the patients mentioned in the foot-note, p. 1028, a very delicate young lady of twenty-two. It was only by not waiting to do more than secure the femoral, making firm sponge-pressure on the flaps, tilting up the end of the table so as to keep the head low, inserting no sutures, but trusting only to firm bandaging over dry gauze dressings, that a fatal result was averted.

† The knife represented here is needlessly long.

tissues in front of Scarpa's triangle with his left hand, enters his knife (*e.g.*, on the left side) midway between the anterior superior spine and the top of the great trochanter, and sends it across the limb so that it emerges close to the tuberosity of the ischium. In traversing the limb the knife should pass as close to the capsule as possible, so as—(1) to get behind the large vessels; and (2) to facilitate the opening of the capsule later on. As the knife emerges, the surgeon will, of course, be careful of the scrotum and the opposite thigh, and at this moment the point should be well depressed, so as to include all the tissues possible in the anterior flap. With a rapid, sawing movement a broad flap is cut, 5 inches long, an assistant thrusting his fingers into the wound as it is made, and following the back of the knife, to secure the large vessels (Fig. 176). As he then draws up the anterior flap, the capsule is exposed, covered with more or less of soft parts, according to the skill with which the knife has been first inserted; the assistant in charge of the limb at this moment extending, depressing, and rotating out the femur, so as to put the capsule on the stretch, the surgeon forcibly draws the knife across the capsule, opens it freely, and divides the ligamentum teres (Figs. 175, 178).

FIG. 176.

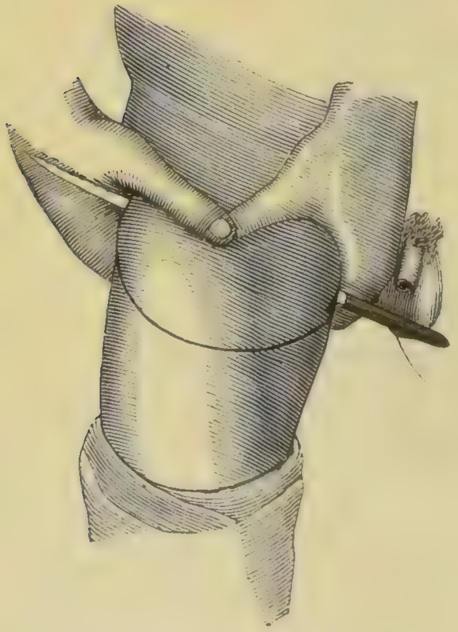
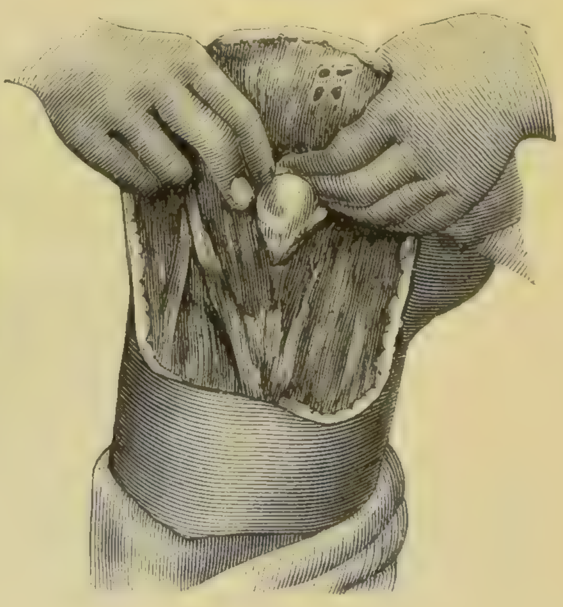
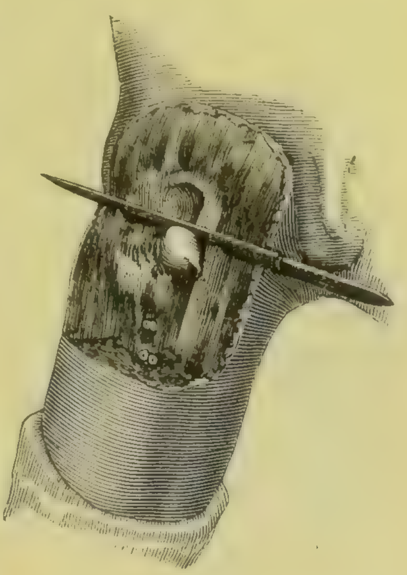


FIG. 177.



The limb being now slightly flexed, adducted, and pulled away from the body, the surgeon severs the parts attached to the great trochanter and the outer aspect of the limb, and passing his knife behind the bone, cuts a posterior flap about 4 inches long. The assistant in charge of the limb will facilitate this step, and further the dislocation of the femur, if he bring the thigh upwards and forwards with one hand placed at the back. A large sponge wrung out of 1 in 20 carbolic acid, is at once pressed against the posterior flap while the femoral vessels * are secured, or, if these are well in hand, those in the hinder flap are taken first. The gluteal will be found in the gluteal muscles, the sciatic with the nerve nearer the posterior margin of the flap, and the circumflex and obturator closer to the acetabulum.

FIG. 178.



If the patient's condition admits of it, any sinuses are now laid open or scraped out, the acetabulum examined, and, if perforated, drained. If the amputation has been for growths, any outlying masses are looked for and removed. Any nerves or muscles which need it are now trimmed short, a large drainage-tube inserted, and the flaps carefully united.†

Advantages of this method. Chief of these is its rapidity.—*Disadvantages.* 1. The hæmorrhage which takes place from the vessels from the posterior flap may be considerable. 2. The large amount of sero-sanguineous oozing which takes place from so many large muscles cut obliquely. 3. The fact that, in an adult, it requires a special long knife, not always found in an ordinary collection of instruments.—*Difficulties.* 1. Not passing the knife deeply enough, and thus not exposing the capsule. 2. Passing the knife too deeply, and hitching its point on the bone. 3. Getting the knife stopped in passing it behind the head of the femur. 4. Fracture of the femur.

Guthrie's Method by Antero-posterior Flaps.—Antero-posterior flaps are again made use of, but here they are made from without inwards, and thus can easily be rendered less bulky. A small knife—*i.e.*, one 4 inches long—suffices.

The preparatory steps being taken as before, the surgeon, standing on the right side of either limb, marks out his anterior flap, about 5 inches long, by an incision, starting (on the left limb) from just above the great trochanter, passing across the thigh with a broadly curved convexity, and ending just below the tuber ischii. A posterior flap is then marked out by carrying the knife in a similar manner across the back of the limb between the same points, the limb being raised and the surgeon stooping somewhat. This flap should be about two-thirds the length of the first. Both consist of skin and fasciæ. The flaps being held out of the way, the muscles, first on the front and then on the back, are next cut obliquely from below upwards, the femoral vessels, both superficial and deep, being secured as soon as they are exposed, and before they are cut, either by underrunning them with an aneurism-needle loaded with silk, or by dividing them between two pairs of torsion-forceps. The capsule being exposed, disarticulation is performed as before.

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* Of these the femoral lies superficially, the profunda more deeply, in the anterior flap: they are shown much too close to each other in Fig. 177.

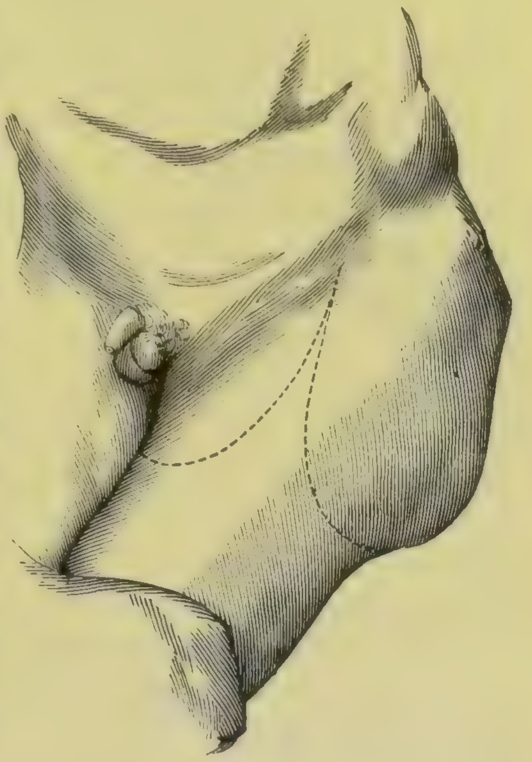
† If the patient's condition is one of grave shock, the head should be lowered and no time lost in putting in sutures, any oozing being stopped by firm spica-bandaging and Spencer Wells' forceps left *in situ*. The lower end of the bed should be kept raised, and brandy given subcutaneously and per rectum.

III. **Lateral Flaps.**—The methods of Larrey and Lisfranc need not be more than alluded to here. In both, the flaps were cut by transfixion, and were about 4 inches long. Larrey tied the common femoral as a preliminary step. Flaps made by either method are so bulky as not to be recommended.

If the surgeon wishes to use lateral flaps, as in a case involved by growth in front, he may make them, thus, from without inwards. Standing on the right side of either limb, he, *e.g.*, in the case of the right limb, marks out an inner flap by means of an incision starting from below the tuber ischii, carried downwards along the inner aspect of the thigh for about 4 inches, and then curving upwards to the centre of the groin and ending, a little below Poupart's ligament, to the outer side of the femoral vessels; next, without taking off his knife, he then marks out an outer flap by cutting between the same points, but in the reversed direction. This incision, as it passes downwards, outwards, and backwards, should leave the front of the limb about a hand's-breadth below the great trochanter. The flaps being dissected up, the soft parts are cut through from without inwards, the femoral vessels being secured before they are cut, and disarticulation performed last.

IV. **Antero-internal and Postero-external Flaps** (Fig. 179).—This is a modification of the last method, and may be useful in cases of growth extending high up, where it is impossible to perform a Furneaux Jordan's amputation. Some such flaps as the above may be the only ones obtainable. They may be made as follows:—The precautions as to shock given at p. 1031 having been taken, the patient's pelvis having been brought well down to the edge of the table, and the opposite limb being held aside, but not tied, the surgeon, standing to the right of either limb, reaches somewhat over and marks out (in the case of the right limb) an antero-internal flap, by cutting from a point close to the tuber ischii to one a little below and internal to the anterior superior iliac spine. The skin and fasciæ being dissected up, the muscles are cut through till the femoral vessels are reached and secured. Large carbolized sponges are now pressed into this wound, and, the patient being rolled a little over, a postero-external flap is marked out and dissected up from the gluteal region, passing between the above points, but in the reverse order. The gluteal vessels are next cut through, the chief vessels being secured by either torsion or Spencer Wells' forceps; the capsule is then opened, the round ligament severed, and the limb removed.

FIG. 179.



EXCISION OF THE HIP.

Indications.—A. Disease. B. Injury, especially gunshot.

A. **Disease.**—The value of this operation still remains unsettled. In spite of all the work done in this direction, there is no other operation of equal importance on which there is still such extreme difference of opinion on the chief questions which have been raised again and again—viz., **Does it save life? Does it shorten treatment? Is the limb a better one?**

Thus, to take two of the most recent writers on hip disease and the subject of excision, Mr. Howard Marsh,* with his experience gained from Ormond Street and the Alexandra Hospital for Hip Disease in Childhood, and Mr. G. A. Wright,† of Manchester and the Pendlebury Hospital for Sick Children. Mr. Marsh is strongly against excision, for these reasons. He considers the results obtained by continued rest to be such as to render excision totally uncalled for. Thus, continued rest gives a mortality of only 5 per cent., 70 per cent. of the cases thus treated recovering with only slight lameness and loss of movement. Even when suppuration has occurred, the mortality is only 6 or 8 per cent. Again, at p. 309, Mr. Marsh writes: "The estimate that I have been led to form is, (*a*) that, in the early stage of the disease, although matter is developed, the operation is as unjustifiable as it is to remove a testis, an eye, or a tooth for incipient but still curable disease; (*b*) that the operation is generally uncalled for, even when sinuses have formed; (*c*) that if hip disease has been allowed to reach the stage in which the bones have become extensively carious, in which matter has burrowed widely, and in which the general health has become seriously affected, excision will be of very doubtful benefit. The operation will be fatal in at least 10 per cent. of the cases, while in another 20 or 25 per cent. it will be followed by no improvement in the patient's condition."

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* *Diseases of the Joints*, p. 317.

† *Hip Disease in Childhood*, p. 93.

On the other hand, my old friend, G. A. Wright, speaking from the very large experience of over a hundred cases of excision, of which only three, at most, died of the direct results of the operation, strongly urges that the hip should be excised "as soon as there is any evidence of external abscess . . . . and still better results would, I believe, be obtained by operating before the pus has escaped from the articulation. The operation is discredited because it is put off until disease is so far advanced that no treatment can have more than a fraction of good results, while timely excision cuts short the disease, saves pain, lessens the time of treatment, and gives a better limb." And again, at p. 97 of his book, Mr. Wright says: "While fully aware that abscesses disappear and tuberculous lesions cicatrize under favourable circumstances, I think that, in the case of the hip, delay is unwise amongst the hospital class, with whom it is as yet impossible to deal on the same lines as with the well-to-do. In almost every instance I have found much more extensive disease than might be expected from the external evidence, unless the pathology of the affection is borne in mind, and I believe that, once this chronic osteo-myelitis is established, nothing short of excision can, *in hospital cases*, prevent the ultimate progress of the disease to abscess, and too often to gradual exhaustion of the patient by pain and discharge. Nature, of course, in many cases will, unaided, get rid of the dead bone by slow and tedious processes, but the number of children who can survive the process of elimination is very small, while the mortality after early excision is not great, and the failures are mainly in those instances where the operation has been put off till too late. Where actual necrosis, or caries of the head of the femur, with destruction of bone and cartilage, and often sequestra of varying size in the acetabulum, or at least caries of it are known to exist, I think few advocates of non-operative treatment will be found." With reference to so wide a divergence of opinion between two authorities on the subject, it may be pointed out that Mr. H. Marsh has worked under conditions more favourable than those which fall to the lot of most hospital surgeons. Thus, at the Alexandra Hospital, cases are kept under treatment as long as rest and extension are required; if an operation is called for, the case is transferred elsewhere. While every one must admire Mr. Marsh's success, it is clear that the conditions under which it has been gained must, as yet, stand alone.

My own opinion as to the advisability of excision in the ordinary hip disease of hospital children is, that it should be resorted to (1) when suppuration is present, and has resisted a due trial of rest, and antiseptic incision and drainage, this latter step giving an opportunity, though a limited one, of investigating the amount of disease present; (2) when there is much thickening about the great trochanter; and (3) when there is much pain, especially at night, not yielding to a due trial of rest. But while I should thus advocate the performance of the operation in the second stage, I think that sufficient importance has not been attached to the fact that disease of the hip-joint is, unless not only seen but treated in the first stage, severe and progressive, and, *per se*, likely to end fatally; if this be so, excision must not be too much reproached with failure. The depth of the joint, the needful interference with soft parts, the difficulty of keeping the wound aseptic, the kind of patient, and the tubercular origin of the disease, must always be remembered. For these reasons I cannot agree with G. A. Wright (*Dis. of Child.*, p. 558), "that excision," as soon as suppuration and other evidence of necrosis is present, "should be looked on as an ordinary operation for necrosis, and the operation itself is not necessarily attended by a higher mortality than sequestrotomy elsewhere."

The conditions which usually accompany obstinate suppuration, and which thus call for excision, are those six given by the Clinical Society's Committee on excision of the hip-joint—viz:

i. "Necrosis, and separation of the entire head of the femur, and its conversion into a loose sequestrum."*

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* Mr. Marsh (*loc. supra cit.*, fig. 50, p. 383) thinks that these cases are not

ii. "The presence of firm sequestra either in the head or neck of the femur, or in the acetabulum." This question is a most important one, for as Mr. Marsh (p. 318) writes, "much difference of opinion exists as to the frequency with which hard sequestra of any material size are present in suppurative hip disease." He himself thinks that when present sequestra usually consist of porous, friable bone. Their structure is such that, should excision not be performed, they will crumble away and disappear, and will not prevent repair.* A distinctly different opinion is held by Mr. Wright (*loc. supra cit.*, p. 118): "here opening of abscesses, and, still less, expectant treatment, can hardly be considered a satisfactory mode of getting rid of sequestra, yet in no less than in 39 (out of 100) were there actual loose sequestra, while in many others there were patches of bone which was practically dead though not loose. The possibility of removing sequestra without a formal excision is worth trying in some cases, but it is often impossible to discover the presence of the sequestra until the end of the bone has been removed, or to extract them if found. Moreover, even after the removal of sequestra, others may exist and not be found, and in other instances the disease progresses in the surrounding bone and necessitates subsequent excision. There are often, too, other foci of disease in the medulla, which are as great bars to recovery as the sequestra themselves."

iii. "Extensive caries of the femur, or the pelvis, leading to prolonged suppuration and the formation of sinuses."

iv. "Intra-pelvic abscess following disease of the acetabulum."

With reference to these conclusions, I should doubt myself whether excision can be often justifiable, especially in the latter. Even if it gave the desired drainage the patient's condition with disease of the acetabulum is not one usually to give the required repair after excision. "Extensive caries" of the pelvis certainly, and in many cases of the femur, will require amputation, especially after childhood.

v. "Extensive and old-standing synovial disease and ulceration

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rare. Mr. Hilton (*Rest and Pain*, fig. 63, p. 341) shows a similar specimen. I should have thought the condition a very uncommon one.

* "This seems to be proved by the fact that in numerous cases in which profuse suppuration has been going on, so that there can be no reasonable doubt that extensive bone disease has been present, all the sinuses will close, although either no bone has worked out or been extracted. In these instances we must conclude either that no sequestra were present, and in that case it would appear that sequestra are not so common as some believe; or that they often crumble away and are discharged, so that operative interference is by no means essential for their removal" (Marsh, *loc. supra cit.*, p. 319).

of the articular cartilages, with persistent suppuration." This condition is rarely seen in the hip-joint, where the disease, as usually met with, starts not in the synovial membrane, as in the knee-joint, but as a chronic osteo-myelitis in the neighbourhood of the epiphyses, especially the upper one.

vi. " Displacement of the head of the femur on the dorsum ilii, with chronic sinuses and deformity."

This condition will probably be more rarely met with nowadays, as earlier facilities for treating hip disease arise. I happen to have performed excision seven times for such cases; of these six recovered with sound and useful limbs,* but in one, a lad of eighteen, in which the sinuses had closed some years before the operation, I should now prefer to improve the condition of the limb by a Gant's osteotomy and division of the contracted sartorius, tensor vaginæ, and adductor longus. These patients seem to me to bear excision well, this being probably due to their having good vitality, as shown by their survival, and the amount of repair. Further, in running successfully the gauntlet of the disease, they have escaped the dangers of lardaceous and general tubercular trouble. The surgeon must here be prepared for a good deal of trouble in dislodging the displaced head, after sawing through its neck owing to its being firmly matted down by old adhesions.

The Condition of the Limb. Is this a better one after Excision or after a Cure by Rest ?

Here, again, the divergence of opinion is marked and puzzling. Mr. Marsh (*loc. supra cit.*, p. 308) is of opinion that " the limb after excision of either the hip or the knee is usually very inferior to the average limb that is obtained after recovery has followed the treatment by rest." Mr. Holmes (*Syst. of Surg.*, vol. iii. p. 757, 1883) thinks that, while recovery after excision of the hip-joint is very complete, as far as the movements of the limb are concerned, " the shortening is generally greater than after the spontaneous cure, and the limb is less firm, and, on the average, less useful." The Clinical Society's Committee reported on this subject that, after excision, " movement is more frequently present, and is also more extensive, but that patients often walk more insecurely and with a considerable limp, while the limb after treatment by rest and extension, though frequently more or less fixed, is more firm and useful for the purposes of progression. While feeling assured that the resulting usefulness in *some* cases treated by excision far surpasses the best results obtained by rest, I consider that the *average* result obtained by rest is superior to that following excision, and that this is increasingly marked after childhood, the limb, in adolescents recovering after excision, being very often flail-like and useless.

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* The seventh has only just been operated on.

On the other hand, Mr. Wright, whose large experience on this subject has already been referred to, has come to the conclusion (*loc. supra cit.*, p. 126) that "excision gives a better limb than the average result obtained without operation;" and again (p. 114): "In my own experience, useless, flail-like joints are exceedingly rare, and limited to those cases where the excision was performed in very late stages of the disease; the powerless condition is, I take it, the result of the disease, not of the operation." With regard to the two conditions which chiefly interfere with the usefulness of the limb after hip-excision—viz., a flail-like state, and shortening, Mr. Wright's opinion on the former has already been given. With regard to the latter, he considers (p. 108), that "though some shortening must necessarily result, this arises mainly from the weight being borne upon the limb prematurely. . . . . Growth in length of the femur takes place almost entirely at its lower epiphysial line, hence the loss of length or true shortening is only the distance from the line of section to the top of the head, coupled with such arrest of growth as may result from impaired nutrition, this last being, of course, a very inconstant quantity."*

Conditions of Success in Excision of the Hip.—Amongst these are:—1. Age. I consider the best six to fourteen. After eighteen excision should rarely be performed, Furneaux Jordan's amputation taking its place. Mr. Wright (p. 126) thinks that after fifteen excision should be rejected in favour of amputation. 2. Absence of lardaceous disease. I cannot agree with the conclusion of the Clinical Society's Committee (*loc. supra cit.*, p. 233) that excision is called for, "when, in a case of suppuration, enlargement of the liver and albuminuria, indicating the presence of degeneration of the viscera, is detected." Excision should be performed, in my opinion, only before the appearance of lardaceous disease. When there is evidence of this condition having set in, especially in the kidneys or intestine, amputation is to be preferred.

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* On this matter Mr. Wright quotes Prof. Ollier's (*Rev. de Chir.*, 1881; *Annals of Surgery*, January 1886) estimate that, up to five years of age, the growth of the femur takes place about equally at its two ends; that, after five, the rate of growth of the lower end increases rapidly till it becomes three times that of the upper.

3. Absence of advancing mischief in other joints, or of tubercular lesions in the viscera—*e.g.*, the lung. 4. The disease must be removed as entirely as possible. Thus, in the femur at least, the section must pass below all foci of disease. All sinuses should also be scraped out. 5. Adequate drainage. 6. Careful after-treatment, the wound being kept aseptic. 7. The patient must not be kept too long on his back in hospital air.

B. **Gunshot Injuries.**

Excision of the Hip-joint for Gunshot Injuries, contrasted with Conservative Treatment, and Amputation at the Hip-joint.—For the sake of convenience it will be well to take the above three plans of treatment of gunshot injuries of the hip together. As before, I shall avail myself of the laborious researches and the unrivalled authority on this subject of Dr. Otis. He writes (*Med. and Surg. Hist. of the War of the Rebellion*, pt. iii. p. 165) that the evidence collected during the American war shows that "of the cases of undoubted intra-capsular shot-fracture of the hip treated by conservation, 98.8 per cent. had a fatal termination, that in sixty-six cases treated by excision, the fatality was 90.9 per cent., and that in sixty-six cases treated by exarticulation, it was 83.3 per cent.; but from these results it should not be concluded that operative interference was always indicated, and that amputation was preferable to excision. On p. 121 of *Circular* No. 2, I have already pointed out that the question as to the most eligible treatment of shot injuries of the hip-joint is not susceptible of a purely arithmetical solution, and that the variety of the conditions under which the patients are placed, the diversity in the extent of their injuries, and the inevitable imperfection of all surgical records, forbid any such rigorous comparison. No less than nine of the sixty-six cases of excision were complicated with such lesions of the pelvic walls and viscera as made any operative interference useless; among the sixty-six coxo-femoral amputations, probably all successful cases have been recorded, while some fatal cases may remain unpublished, and in the 304 cases treated by conservation, the correctness of the diagnosis may be questioned in many instances. The character of the injury must determine the choice of treatment; but the general rules regarding shot wounds of the hip-joint laid down in *Circular* 2 are uncontroverted: that expectant treatment is to be condemned in all cases in which the diagnosis of direct injury to the articulation can be clearly established," that "primary excisions of the head or upper extremity of the femur should be performed in all uncomplicated cases of shot fracture of the head or neck;" that "intermediary excisions are indicated in similar cases where the diagnosis is not made out till late;" that "secondary excisions are demanded by caries of the head of the femur or secondary involvement of the joint;" that amputation should be performed—"1. When the thigh is torn off, or the upper extremity of the femur comminuted with great laceration of the soft parts, in such proximity to the trunk that amputation in continuity is impracticable. 2. When a fracture of the head, neck, or trochanters of the femur is complicated with a wound of the femoral vessels. 3. When a gunshot fracture involving the hip-joint is complicated by a severe compound fracture of the limb lower down, or by a wound of the knee-joint."

It is possible that Dr. Otis's opinion as to the uselessness of expectant treatment in gunshot injuries of the hip-joint will need alteration in the future—*i.e.*, Prof. Langenbeck,* from his experience in the Franco-German war, considered that the expectant treatment gave a larger proportion of recoveries than excision, and still more than amputation, and advised that the expectant method should always be resorted to save when disarticulation is rendered inevitable by the destruction and shattering of the limb. Sir T. Longmore, *System of Surgery*, vol. i. p. 561, thinks that this question must be held to be "still *sub judice*, and surgeons must wait for still more extended experience, under modern improved methods of treatment, before any rule can be accepted as having yet been established on this grave question."

Examining into the dates at which the excisions of the hip were performed, Dr. Otis (*loc. supra cit.*, p. 126) gives the mortality rate as 93 per cent. for the primary, 96.6 per cent. for the intermediary, and 63.4 per cent. for the secondary operations. Thus, "the excisions and amputations practised during the intermediary or inflammatory stage are by far the most dangerous, and should never be performed except as compulsory operations."

As to the dates of the exarticulations of the 254 cases, there were 82 primary, with 75 deaths (91.4 per cent. mortality); 55 intermediary, with 52 deaths (94.5 per cent.); 40 secondary, with 33 deaths (82.5 per cent.); the reamputations gave a mortality of 36.3 per cent. Dr. Otis shows from these statistics that "intermediary operations offer the least chance of recovery, that the results of primary operations are more favourable; that secondary exarticulations give one recovery in twelve cases ; and that of the instances of re-amputation one in about three proves successful. . . . . Unless the nature of the injury is such that the operation can be delayed till the secondary period, it is better that it should be done at once, although it would appear that the dire results of amputations at the hip performed during the Schleswig-Holstein war of 1864, the Austro-Russian war of 1866, and the Franco-Prussian war of 1870–71, have had a tendency to raise doubts regarding the expediency of, especially the primary, exarticulation of the hip."

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* *Arch. f. Klin. Chir.*, 1874, Bd. xvi. S. 309–316. The recoveries seem to have been twenty-five out of eighty-eight cases so treated.

Operation.—Two will be described here: A. **By posterior incision** ; B. **By anterior incision.**

A. **Posterior Incision** (Fig. 180).—The chief advantage of this is its better drainage, a point which outweighs, in my opinion, where suppuration is present, the smaller interference with muscles entailed by the incision in front (p. 1047).

While the patient is being brought under ether, a stirrup is applied if weight-extension is to be made.* The child being rolled over on to his sound side, and the parts thoroughly cleansed, the surgeon stands usually outside the limb, the patient's body being in either case placed conveniently at the edge of the table, one assistant supporting the limb, while another is opposite to the surgeon. An incision, about 3½ inches long,† is now made over the middle‡ of the great trochanter, commencing about midway between the top of this bone and the anterior superior spine, and ending over the shaft, just below the trochanter. The incision should curve slightly forwards and pass down to bone or cartilage, as the case may be, at once. Any bleeding vessels being secured, the exact position of the head and neck is now made out by an aseptic finger, aided by an assistant rotating the limb. A second incision opens the capsule freely. With a periosteal elevator, aided by a knife, the muscles attached to the great trochanter are detached, the cartilage in young subjects peeling off with them in one or more pieces. The finger is now passed round the neck of the femur and the soft parts, including the periosteum, detached as much as possible on the inner side. The finger, now feeling that the upper part of the trochanter and the neck of the bone are free, and protecting the soft parts on the inner side, the bone is sawn through just below the top of the trochanter with an osteotomy, metacarpal, or keyhole saw.* This division should be thoroughly and cleanly effected without splintering. If it be preferred, in addition to the protection of the finger on the inner side, a blunt dissector may be passed behind the bone as well, but this is not essential: retraction will protect the lips of the wound from the saw. With the aid of the finger and an elevator, or with a lion-forceps, the head and neck of the bone are levered out of the acetabulum, this being often attended with some difficulty unless the capsule has been very freely opened. The ligamentum teres is probably destroyed; if not, it must be divided. The acetabulum is then examined, and, if merely roughened, left alone; if pitting or erosion be present, gouging must be resorted to.†

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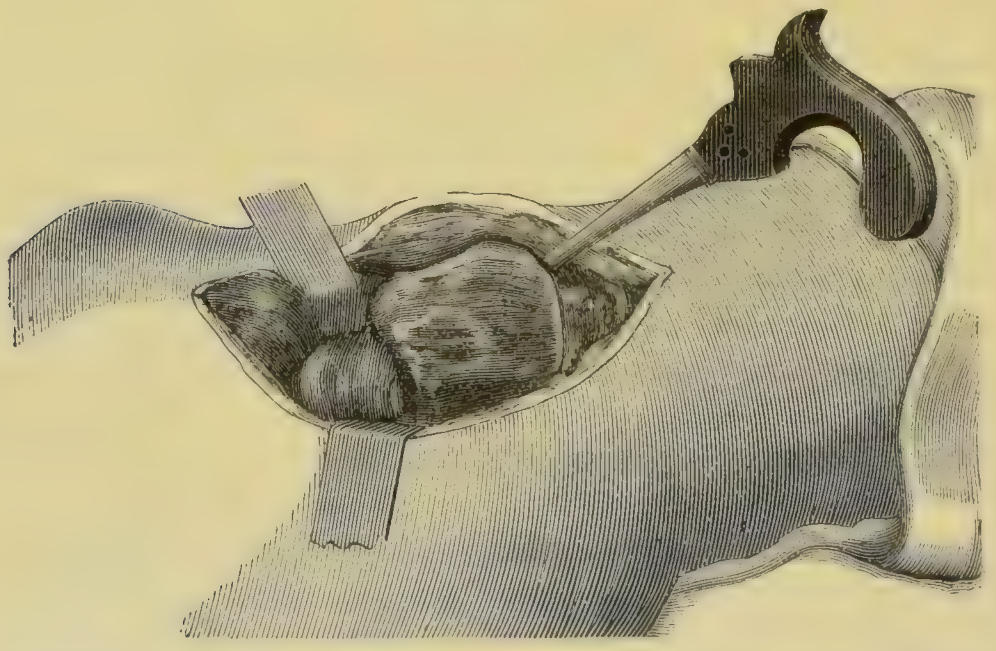
* There is no occasion to apply an Esmarch's bandage above the wound ; and rendering the limb evascular, save by elevation, is often rendered impossible by the presence of an abscess or sinuses.

† This is usually sufficient in a child. But it must be always remembered that a small wound, by giving insufficient room, leads to bruising and difficulty.

‡ The advantage of going as far forward as this is, that the fleshy and vascular parts of the muscles attached to the great trochanter are better avoided.

FIG. 180.



Excision of the hip. The saw is applied rather lower down than usual. Above the great trochanter the neck and head are seen indistinctly.

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* The section of the bone should always be made while this is *in situ*. The plan of dislocating the head by adducting the limb, and then sawing it off, disturbs the parts more, and runs the risk of fracturing the wasted femur of a little child, an accident which I have seen occur in the hands of a very careful operator. Mr. Wright (*loc. supra cit.*, p. 101) states that he had one case among his earlier operations, and that he has also separated the lower epiphysis in an infant while manipulating the femur during incision of the joint. He points out another objection—viz., the ease with which the periosteum may be stripped off if the head of the bone is thrust out.

† Any sequestra present must be removed. If the acetabulum is perforated, and pus present on its pelvic aspect, free exit must be provided by means of a gouge or small trephine, and a drainage-tube passed through.

Any bleeding points are now looked to,* and drainage provided to the very bottom of the acetabulum. No sutures should be inserted.

Site of Section of the Femur.—Having tried both, I think that the section through the great trochanter (*i.e.*, just below its upper margin) is preferable to one above it (*i.e.*, through the neck). This has the *advantages* of disturbing and damaging the attachments of muscles much less, and thus leads to more rapid healing and far greater mobility of the limb. These, however, are outweighed by the *disadvantage* which leaving such a large piece of bone as the trochanter entails—viz., that after healing, this process gets drawn up against the scar and constantly frets it.† It is also said to check the escape of discharges, and to render the patient liable to persistence or recurrence of the disease. I am doubtful as to the last two, but the first is absolutely certain.

B. Mr. A. E. Barker‡ has shown what excellent results the anterior incision can give. In his Hunterian Lectures (*Brit. Med. Journ.*, 1888, vol. i. p. 1326) he advocated the use of this mode of excision in the early stage of hip disease. In later papers (*Ibid.* ii., 1888, p. 1337, and 1890, vol. ii. p. 1009) he published some most successful cases thus treated in later stages, where other means had failed, and abscesses were threatening to burst. He advocates the anterior incision on the following grounds especially, (1) the interference with the muscles is practically *nil;* (2) the patient can thus be treated and his wound dressed much more conveniently—*e.g.*, with a Thomas's splint; (3) primary union can be secured if the following most essential points are strictly attended to; (*a*) the whole of the diseased structures must be removed; (*b*) perfect asepsis must be secured;

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* The hæmorrhage is usually very slight. Firm plugging around the drainage-tube with strips of sal alembroth or iodoform gauze will arrest troublesome oozing, and is preferable to spending time in trying to secure vessels, unless these spring distinctly.

† About ten years ago I made use of this method in one case, sawing the bone through the neck and leaving the trochanter entire. A rapid recovery took place, and the boy quickly recovered power over the limb. He has long been able to run and climb like other lads, and the movements of flexion, extension, abduction, and adduction are extraordinarily perfect. He has, however, been under my care on several occasions for superficial ulceration of the scar, which is fretted by the very prominent upper margin of the immediately subjacent trochanter.

‡ Mr. R. W. Parker (*Clin. Soc. Trans.*, vol. viii. p. 108) recommended this method as interfering less with the muscles and the blood supply of the joint. Hüter was, I believe, really the first to use this incision, draining the joint by a counter puncture at the back.

(*c*) all oozing must be checked, and the wound kept dry by well-applied dressings; (*d*) absolute rest must be maintained during healing. With regard to the objection which has usually been considered to be fatal to the anterior incision, viz., the insufficient drainage which it gives, Mr. Barker replies that the incision, though anterior, is perfectly adequate for drainage, (1) because the discharges are, if the above given precautions are duly followed, very small in quantity, "little more than odourless serum, which ought never to become truly purulent;" (2) "if all the tubercular tissue is removed, a clean walled cavity is left, most of which is quite capable of healing by first intention, when its different surfaces are brought into close contact by firm pressure. And in these cases, the head of the bone being removed and the acetabulum quite clean, the cut surface of the neck of the femur can be brought close up to the latter, so that although there is potentially a large space in the field of operation, there ought to be actually little or no cavity left, if pressure have been properly applied from the first."

Of the conditions which it is absolutely necessary to secure for the obtaining of primary union, and the success of the anterior incision, the first—that the whole of the diseased structures must be removed—is by far the most important. It is also, from my experience of five cases in which I have used this method, the most difficult to secure, three of the above healed quickly, but two still leave a sinus. G. A. Wright (*Brit. Med. Journ.*, 1888, vol. ii. p. 1338), speaking at the discussion on one of Mr. Barker's papers, said that he had found the entire removal of the morbid tissues practically impossible either by the anterior incision which he used occasionally, or by the posterior. Only little foci of disease might be left, but they were apt to suppurate when some fall or accident gave them the opportunity. At present, while we must still wait for the light which further carefully reported cases alone can give us, all hospital surgeons will agree that Mr. Barker's brilliant work in this field promises to inaugurate a new epoch in that most baffling point in surgery, the operative treatment of hip disease.

Operation.—The patient being on his back, with the limb extended, and the parts duly cleansed, the surgeon standing, in the case of either limb, on the right side, makes an incision 3 to 4 inches long, starting ½ inch below the anterior superior spine downwards, and slightly inwards, between the tensor vaginæ and glutæi externally and the sartorius and rectus internally. The upper part of this incision should pass down to the capsule at once, the lower third should divide skin only. A second incision in the upper part of the first should certainly open the capsule. An aseptic finger now examines the condition of the joint. The wound being opened by retractors, a narrow-bladed saw is introduced in the upper part, in the direction of the wound, *in situ*, and with as little damage to the soft parts as possible. The head of the femur is now extracted and the acetabulum treated by the means given at p. 1046.

The advantages and disadvantages of this step have been already given at p. 1047. In a case at all advanced there will always be a risk that a section as high up as this will expose diseased bone. Every atom of diseased structure must now be removed, especial care being taken to clear out any caseating abscesses communicating with the joint. All this should be done with as little violence as possible to the surrounding tissues, so that none of the tubercular débris be forced into the freshly cut surfaces. The best means of removing the disease thoroughly is Mr. Barker's "flushing gouge" (*Brit. Med. Journ.*). This has a cutting scoop-like edge, is perforated, and to its hilt is attached tubing which communicates with an irrigating can. By this means boiled water (F. 105°) is kept flowing through the area of operation carrying away the débris of disease whether from abscess cavities, the joint, or the surface of the acetabulum, if diseased, and with it all blood, while at the same time it arrests hæmorrhage. When every part of the field of operation has been gouged and scraped clear of all tubercular material, and the water runs clear, the cavity is dried out with carbolized sponges, one or two of which are left in it, until all the sutures are *in situ*. These should dip deeply, and be placed close together. Just before they are tied, the sponges are removed, and with them the last tissue of moisture. The wound is then filled up with iodoform emulsion, and the sutures are tied, as much of the emulsion as will come away being squeezed out at the last moment. Graduated, even pressure is then applied by the dressing and bandages, so that the walls of the cavity are brought into apposition, and the remainder of the neck of the femur secured in the acetabulum. The patient is then placed in a double Thomas's splint.

I have only space here to urge that cases of hip excision should be got up as early as possible—*i.e.*, at the end of six or eight weeks. A double Thomas's splint, with foot-pieces, should be applied immediately after the operation, and worn for a period of from four to eight months. After this the child should get about on a patten and crutches, swinging the affected limb. He should not be allowed to use this for upwards of a year after the operation. If weight is borne on this earlier, it is pushed upwards on to the dorsum ilii, and much shortening is the result. Mr. Barker has allowed some of his cases to get up and dispense with a splint at a much earlier period. I think the above-given dates better suited to most cases of excision of the hip, when we remember the risks to which they are exposed by their rough-and-tumble life when they leave the hospital.

Usual Causes of Failure after Excision of the Hip.

1. Persistent pelvic disease. 2. Chronic osteo-myelitis of sawn end of femur. 3. Suppuration and hectic. 4. Lardaceous disease. 5. Tubercular conditions elsewhere. General outbreak of tuberculosis. 6. Disease of the opposite femur.

CHAPTER II.

OPERATIONS ON THE THIGH.

LIGATURE OF THE COMMON FEMORAL.—LIGATURE OF THE SUPERFICIAL FEMORAL IN SCARPA'S TRIANGLE.—LIGATURE OF THE SUPERFICIAL FEMORAL IN HUNTER'S CANAL.—PUNCTURED AND STAB WOUNDS IN MID-THIGH.—AMPUTATION THROUGH THE THIGH. — AMPUTATION IMMEDIATELY ABOVE THE KNEE-JOINT. — REMOVAL OF EXOSTOSIS FROM NEAR THE ADDUCTOR TUBERCLE.—UNUNITED FRACTURE OF THE FEMUR.

LIGATURE OF THE COMMON FEMORAL (Fig. 181).

THOUGH this operation is not regarded with much favour, especially for aneurism, it will be described here, as the question of tying it arises from time to time, and as it should always be performed for the sake of practice, on the dead body.

Indications.

1. Wounds.—These are rare here compared with those affecting the vessels lower down. The wound must always be explored and the bleeding-point sought, for two reasons—(*a*) Ligature of the external iliac will usually fail to arrest bleeding from the common femoral. (*b*) The source of the bleeding may easily be mistaken here; thus, Mr. Liston,* in a case of pistol-shot wound of the groin, tied the external iliac for what was proved, post mortem, to have been a wound of "one of the superficial branches of the common femoral, about $\frac{1}{2}$ inch below Poupart's ligament."

After ligature for gun-shot injuries, whether for direct or for consecutive bleeding unattended by primary injury to the vessel, the mortality in the American war[*] seems to have been high—over 70 per cent.

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* *Med.-Chir. Trans.*, vol. xxix. p. 107. The flow of blood here is said to have been "most impetuous and profuse." In Mr. Liston's words: "The division of even a small branch close to the principal vessel, it is well known, pours out blood furiously, as much so, in fact, as if an opening in the coats of the artery itself were, so to say, punched out, corresponding in size to the area of the branch.

The very important subject of ligature of the femoral artery or vein, or both, in cases of wounds, will be referred to here, though briefly. Such cases will arise most frequently in removal of growths—*e.g.*, epitheliomata, lymphomata, sarcomata—less often in cases of stabs. Much interesting information on these subjects will be found in papers by M. Kirmisson[†] and Dr. L. Pilcher.[‡]

2. Removal of Growths from Scarpa's Triangle and Injury to Femoral Vessels. M. Kirmisson has lately drawn attention to the following points:—In the course of the deeper dissection the pulsation of the femoral artery should be frequently felt for with the finger. As this vessel may have been displaced, it is not enough to trust to anatomical knowledge alone. After separating the structures on either side of the tumour, this should be left adherent where in connection with the sheath, and especial care devoted to this spot. Where the adhesions are very firm, and where a large tumour surrounds the sheath, it is useful to divide the tumour and to remove large parts of it, only preserving that part in intimate connection with the vessels, this being finally separated most carefully. In the case of growths in intimate connection with the sheath the vein is particularly in danger, because (*a*) the vein-walls are much more quickly invaded than the arterial, and (*b*) the vein is in closer connection with the glands. Two conditions are likely to be met with by the surgeon: 1. Denudation of the vessels. Here the adhesions are sufficiently loose to be separated, and the sheath is either left intact or opened. Every effort must be taken to keep the wound here aseptic. 2. Resection and ligature of one or other of the femoral vessels. If the vein alone has been injured in an operation or by a stab, it should be secured if possible by a laterally applied ligature, or by the application of Spencer Wells' forceps left *in situ* for two or three days.[§] These being impossible, or failing, the

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[*] Otis, *Medical and Surgical History of the War of the Rebellion*, part iii. pp. 16, 43. 49.

[†] *Rev. de Chir.*, May 10, 1886. I am indebted for my knowledge of this paper to an abstract by Mr. T. Jones, of Manchester (*Med. Chron.*, September 1886, p. 514).

[‡] *Annals of Surgery*, February 1886.

[§] A case in which I thus treated a wound of the internal jugular has been recorded at p. 464. Pilcher mentions a case of Kuester's, in which a wound in the vein was secured with hæmostatic forceps; the removal of these after only twenty-four hours was followed by renewed bleeding, ligature of the femoral artery, and fatal gangrene.

femoral vein must be ligatured. Dr. Pilcher, quoting from a paper of Braun's,* shows that of eighteen cases in which ligature of the femoral vein alone was practised at the level of Poupart's ligament, thirteen occurred as the result of wounds inflicted during the removal of tumours. In none of these tumour-extirpation cases did gangrene ensue.†

The question has been raised lately whether, when ligature of the common femoral vein has been found needful, the common femoral artery should not be tied also, in order to diminish the risk of gangrene. Dr. Pilcher, while quoting the cases of Roux, Linhart, and Langenbeck, in which this step was successful, shows that the practice of ligature of the common femoral artery as a prophylactic step after wound of the common femoral vein high up, whether in the removal of tumour or in injuries—*e.g.*, stabs, is to be discouraged.‡

Dr. Pilcher suggests (*loc. supra cit.*, p. 119) that where the femoral vein has been suddenly and completely occluded high up it will be wiser to tie not the common but the superficial femoral artery, as likely to materially diminish the current to the limb, while the amount provided will be quite sufficient for its nutrition.

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* *Arch. f. Klin. Chir.*, Bd. xxviii. Heft 3, S. 610.

† Dr. Pilcher points out that this is due to the gradual enlargement of the collateral venous circulation which takes place during the growth of the tumour. This constitutes a most important difference between wounds of the vein during operation and by a stab. Thus, in five cases in which as the result of acute injuries the femoral vein was tied high up, recovery without disturbance took place in only one. In two, death took place from septicæmia and pyæmia; in the remaining two, gangrene rapidly supervened. In the case of stab wounds of the common femoral vessels the complication of sepsis has to be remembered. Thus, Mr. Gould (*Med. Soc. Proc.*, vol. x. p. 177) published a case of great interest in which the common femoral vein was wounded ("the whole anterior segment of the vessel" being severed) with a cat's-meat knife. A ligature tied round the vein above and below the wound not arresting the bleeding, the internal saphena which entered the femoral just opposite the wound was tied also. Blood still welled up from the wounded vessel, and further search showed that another vein entered the femoral trunk just opposite the wound in the trunk between the two ligatures. This vein was tied and then all hæmorrhage was found to be arrested. Though the wound was very thoroughly irrigated with solution of hyd. per. (1–2000), all the infective material introduced by the knife could not be removed. Septic phlebitis followed, with inflammation of the coats of the artery and hæmorrhage on the ninth day necessitating ligature of the superficial and deep femoral arteries. Meanwhile the septic thrombus had been spreading up the iliac vein until all the chief channels for the return of venous blood were blocked. This brought about moist gangrene, the patient dying on the eleventh day with blood-poisoning, accelerated by the loss of arterial blood.

‡ In support of this, Dr. Pilcher writes: "To diminish, to an extreme degree, the arterial supply to a part whose nutrition is already seriously compromised by general venous stasis, would certainly tend to precipitate and aggravate the threatened necrosis."

In cases where both vein and artery are wounded these must be secured *in situ.* The risk of gangrene is now enormously increased, though the risk will vary somewhat accordingly as the simultaneous ligature is made above or below the deep femoral.

A few other points bearing upon the removal of tumours here may be alluded to. The internal saphena vein should be carefully preserved intact, and where it is really needful to divide it, this should be done as far from the main femoral trunk as possible, otherwise most troublesome œdema may subsequently develop.*

In operating close to Poupart's ligament, and especially on the inner side, the presence of the peritonæum,† and the possible existence of a femoral hernia must be remembered.

3. Ulceration into the Artery by Growths.—From the frequency of growths here this indication will occasionally arise. I have met with one case. A man was admitted under my care who had been operated on elsewhere for the removal of sarcomatous glands in the groin. The application of zinc chloride paste had led to detachment of sloughs and exposure of the common femoral, which gave way, leading to profuse hæmorrhage. I tied the common femoral immediately above the bleeding-point, this was slowly followed by typical dry gangrene, necessitating amputation through the lower third of the thigh.

4. Ulceration into the femoral vessels in inguinal bubo.—Mr. Shield has drawn attention to this most dangerous condition (*Med. Soc. Proc.*, vol. x. p. 261). Though in his case ulceration occurred in the *superficial* femoral vessels I have alluded to it here, in association with the previous two headings. Owing to hæmorrhage from sloughing sinuses in Scarpa's triangle, Mr. Shield was obliged to tie both artery and vein, using two ligatures in each case. There was no return of hæmorrhage, and gangrene did not occur, but the patient sank exhausted on the eleventh day with a large pyæmic abscess in the opposite hip-joint. Mr. Shield points out that in these most dangerous cases of spreading sloughing bubo, preventive treatment—use of the sharp-spoon, chloride of zinc paste, continuous warm baths, &c.—is urgently

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* Dr. Pilcher (*loc. supra cit.*, p. 114) mentions a case where, after ligature of the saphena vein close to the common femoral, the tendency to œdema was so great that the patient, unfitted for work, begged for removal of the limb.

† M. Kermisson gives a case in which the peritonæum was wounded and sutured, the patient recovering.

indicated. When once bleeding has occurred and recurred, as pressure* owing to the condition of the left parts is likely to fail, a free incision and ligature of the vessels above and below the point of ulceration is the wisest course.

5. Aneurism.—There has been much difference of opinion as to whether it is wiser, when dealing with an aneurism on the superficial femoral high up, to tie the common femoral or the external iliac. English surgeons have rejected ligature of the common femoral for these reasons—(1) The risk of gangrene as the ligature is placed above both the great nutrient arteries of the limb. (2) The probability of firm clotting taking place after the ligature is rendered doubtful, owing to the number of small vessels given off here—viz., the superficial epigastric, and circumflex iliac, the superior and inferior external pudic, and very commonly one of the circumflex arteries, and also by the proximity of the profunda. (3) The uncertainty of the origin of the profunda, and thus of the length of the common femoral. (4) I would add to the above that ligature of the common femoral for aneurism approximates the treatment to that of Anel rather than to that of Hunter. Erichsen† goes so far as to say, "It may be laid down as a rule in surgery, that in all those cases of aneurism which are situated above the middle of the thigh, in which compression has failed and sufficient space does not intervene between the origin of the deep femoral and the upper part of the sac for the application of a ligature to the superficial femoral, the external iliac should be tied."

Mr. Holmes,‡ while adducing facts to show that the operation on the common femoral is not in itself by any means so fatal as has been represented, and that no just cause whatever has been shown for banishing it from surgical practice, allows that he should be in favour of ligature of the external iliac for femoral aneurism high up, under ordinary circumstances, and reserve that on the common femoral for cases where the belly is extremely fat.

The opposite opinion has been held by some of the Irish surgeons—viz., the two Porters, Mr. Smyly, Mr. Butcher, and Dr.

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* At the debate on Mr. Shield's paper, Mr. Cripps—a high authority—supported pressure in these cases. It should be applied methodically according to Mr. Cripp's plan (*vide infra*, p. 1062), and, to secure asepsis in these most persistently foul cases, it would be well to try the application of that powerful styptic and disinfectant, turpentine (p. 481).

† *Surgery*, vol. ii. p. 244.

‡ Hunt. Lect., *Lancet*, 1874, vol. ii. p. 300.

Macnamara. The last-mentioned surgeon has published * eight cases, of which six were successful, two dying of hæmorrhage.

It is probable, however, that, for the reasons given above, ligature of the external iliac will be preferred, especially as nowadays antiseptic precaution and improved ligatures will have rendered this operation increasingly safe.

6. As a Preparatory Step to Amputation at the Hip-joint.—The need of this has been largely done away with by the Furneaux Jordan method. Where this is not available, one of the other means given at p. 1028 will, I think, be found preferable.

LINE AND GUIDE.—From a point midway between the anterior superior spine of the ilium and symphysis pubis to the adductor tubercle, and the inner margin of the internal condyle.

Another line is sometimes taken from the centre of Poupart's ligament (or a point midway between the two spines) to the inner margin of the patella or the front of the internal condyle, but that above given is the more correct.

RELATIONS :— IN FRONT.

Skin ; fasciæ ; lymphatic glands.
Crural branch of genito-crural. Sheath.

OUTSIDE.		INSIDE.
Anterior crural.	Common femoral.	Septum of sheath. Femoral vein.

BEHIND.

Sheath.
Psoas.

It is important to note that the common femoral is usually only 1½ inch long, and that from it come off not only the superficial epigastric, circumflex iliac, and superior and inferior external pudic, but occasionally one of the circumflex arteries as well.

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* *Brit. Med. Journ.*, October 5, 1867. Mr. G. H. Porter (*Dub. Journ. Med. Sci.*, vol. xxx. N.S. 1860, p. 302) reports three cases, and alludes to two under his father's care. All were successful, though secondary hæmorrhage occurred in two.

Collateral Circulation.

ABOVE.		BELOW.
Gluteal and sciatic,	with	Superior perforating and circumflex arteries.
Superficial circumflex iliac,	with	Ascending branch of external circumflex.
Obturator,	with	Internal circumflex.
Comes nervi ischiadici,	with	Perforating of profunda and articular of popliteal.

Operation.—The groin being shaved and cleansed, the hip and knee semiflexed, and the limb abducted and rotated somewhat outwards, an incision about $2\frac{1}{2}$ inches long is made in the line of the artery, commencing just above Poupart's ligament. The skin and superficial fascia being divided, and any overlying glands displaced or removed, any veins which may be met with descending to join the internal saphena are either drawn aside or tied between double ligatures of chromic gut. The fascia lata being opened just below Poupart's ligament, the artery or its pulsation is felt for, the vessel exposed here, and the needle passed from within outwards, care being taken to avoid the crural branch of the genito-crural, which lies superficial to the artery. The neighbourhood of any branch is, if possible, avoided. A horsehair drain is then inserted, and the wound carefully closed.

By another method the artery is found by an incision parallel with the centre of Poupart's ligament and about $\frac{1}{2}$ inch below it. This is recommended by Mr. Porter and Dr. Macnamara (*loc. supra cit.*). Of the two, the first in the line of the vessel is to be preferred.

LIGATURE OF THE SUPERFICIAL FEMORAL IN SCARPA'S TRIANGLE (Figs. 181, 182).

Indications.

1. Certain Cases of Aneurism of the Popliteal Artery or the Femoral low down.—Thus the ligature will probably be indicated—(*a*) where a popliteal aneurism is rapidly growing, especially when (*b*) it is on the anterior aspect of the artery instead of behind or at one side of it, as in the former case the knee-joint may become involved after very obscure symptoms; (*c*) when the aneurism is fusiform rather than saccular; (*d*) when it has very thin walls; (*e*) when it threatens to burst, or when this has already happened, unless other symptoms—*e.g.*, gangrene—call for amputation; (*f*) if visceral disease—cardiac, renal, hepatic—or an athero-

matous condition of the vessels is present, the surgeon must weigh carefully the question of operative interference: I should prefer in most cases a trial of the ligature as likely, with the aid of antiseptic precautions, a modern ligature and primary union, to entail less taxing of the patient's powers; (*g*) where a trial of pressure has failed, or is certain to fail from the irritability of the patient.

2. Wounds.—Nothing need be added here to what is said on the subject at pp. 1051, 1061.

3. For Hæmorrhage low down—*e.g.*, after amputation in the middle of the thigh, when other means fail and the wound is nearly united (p. 1063). Two other instances are given by Mr. Bryant (*Surgery*, vol. ii. p. 417). One was "a case of Mr. Bransby Cooper's, in which a compound fracture of the leg was complicated with a laceration of the femoral artery. The artery was secured at the seat of injury, and repair went on well in all respects. Mr. Bransby Cooper has also recorded in his *Surgical Essays* a case of fracture of the femur in which the femoral artery was ligatured for a ruptured popliteal artery, and in which recovery took place in six weeks." Each of such cases must be considered on its own merits, but the above shows what ligature of the femoral artery will do in appropriate cases.

4. For Elephantiasis.—Cases in which the superficial femoral has been tied will be found in the *Lancet* for 1879, vol. i. p. 44; and Ranking's *Abstract* for 1860, vol. ii. p. 193. The subject of ligature of the main artery of a limb for this affection has been considered at p. 609.

5. Acute Inflammation of the Knee-joint. — Mr. Maunder brought a case before the Clinical Society (*Trans.*, vol. ii. p. 37), in which, at his suggestion, Mr. Little had tied the femoral artery for acute inflammation of the knee-joint, ten days after a lacerated wound. The pain and other acute symptoms were at once relieved, and the patient made a good recovery. The antiseptic treatment of wounds of joints aided by free incisions will, nowadays, do away with the need of the above treatment.

LINE.—That above given, p. 1056.

GUIDE.—The above line and the inner border of the sartorius at the apex of the triangle.

RELATIONS.—

IN FRONT.

Skin; superficial fascia; glands; crural branch of genito-crural nerve; middle cutaneous and branch of internal cutaneous; fascia lata; sartorius.

OUTSIDE.	INSIDE.
Femoral vein (below). Anterior crural nerve, and some of its branches—viz., nerve to vastus internus, and long saphenous nerve.	Femoral vein (above).

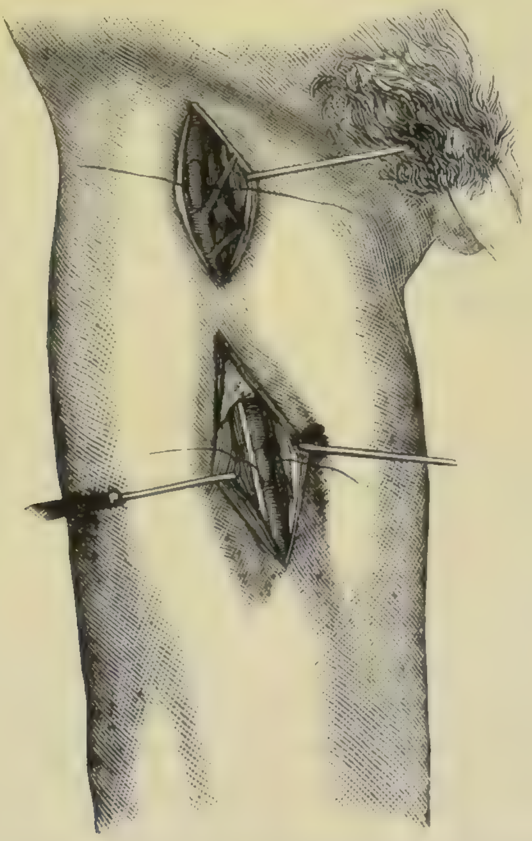
BEHIND.

Psoas; pectineus; adductor longus; femoral vein (below); profunda vein; nerves to pectineus.

Collateral Circulation.

ABOVE.		BELOW.
Perforating of profunda,	with	Lower muscular of femoral, articular of popliteal, and anterior tibial recurrent.
External circumflex of profunda,	with	Ditto ditto.
Comes nervi ischiadici,	with	Perforating of profunda and articular of popliteal.

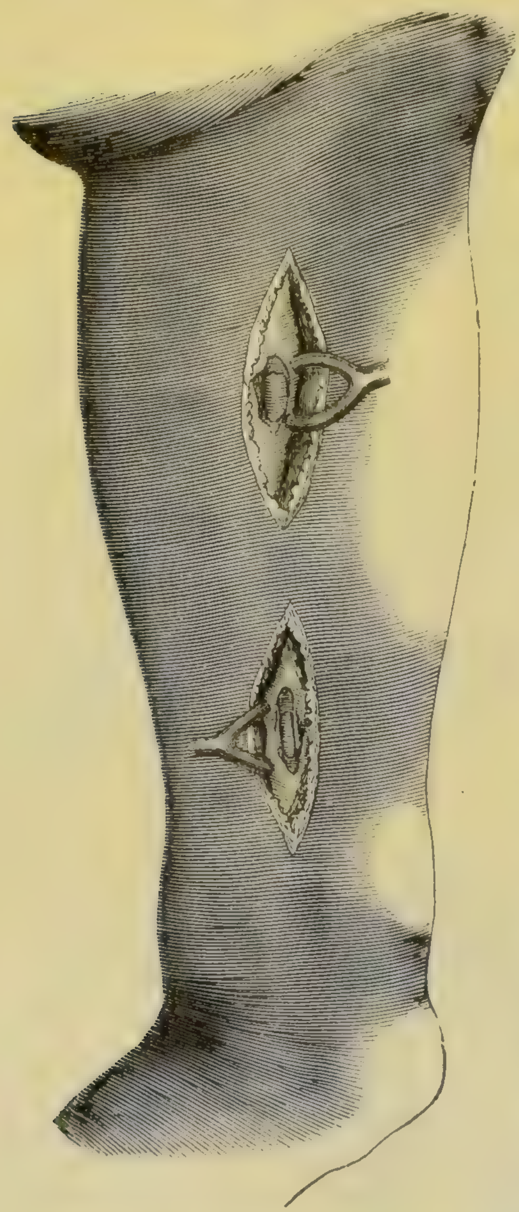
FIG. 181.



Ligature of the common femoral, and the superficial femoral at the apex of Scarpa's triangle. The ligature in each case has been passed from within outwards. (Sédillot.)

Operation (Figs. 181, 182).—The parts being shaved and cleansed, the knee and hip slightly flexed, the thigh abducted and somewhat everted, and the leg resting on a pillow, the surgeon, seated or standing to the right of the affected limb, makes an incision 3 inches long in the line of the artery (p. 1056). This should begin about 2½ inches below Poupart's ligament, and run down to, and somewhat below, the apex of Scarpa's triangle, which lies usually 4 to 5 inches below Poupart's ligament. The skin and superficial fascia being divided, any small vessels are secured, and branches of the saphena vein drawn aside with a strabismus hook or secured with double chromic-gut ligatures. The deep fascia is now slit up for the whole length of the wound, and the inner margin of the sartorius, which crosses the lower part of the incision, identified. This is then turned outwards, and so held with a blunt hook or retractor, while the artery or its pulsation is felt for. The wound being now well opened out with retractors and carefully wiped out, the sheath is opened to the outside, care being taken to avoid the nerves in contact with it—viz., the long saphenous, or the nerve to the vastus internus. The artery being cleaned, thoroughly but most carefully, on either side and behind, the needle is passed from within outwards, being kept very close to the vessel so as to avoid the vein which lies behind and internally.*

FIG. 182.



Ligature of the superficial femoral at the apex of Scarpa's triangle, and in Hunter's canal. Above, the sartorius (the only structure which happened to be met with) is drawn outwards. Below, it is drawn inwards. The long saphenous nerve lies on the outer side of the artery, here.

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* The vein is so frequently damaged here, especially on the dead subject, that a few precautions may be given as to the best way of avoiding it. First, the sheath must be identified exactly, and sufficiently opened at its outer part. It

The artery being tied, the ligature is cut short, drainage provided by horsehair or a small tube, according to the amount of disturbance of the parts, &c., and the wound closed. The precautions given at p. 613 for the prevention of gangrene must be taken.

Difficulties and Mistakes.

1. Wounding the Saphena Vein.—This may occur if the incision is made too internal. It is always to be avoided if possible, owing to the troublesome œdema which may follow. 2. A very broad Sartorius. 3. Injury to the Femoral Vein.—This may easily take place if force is used in pushing the needle round an imperfectly cleaned artery, or if the needle is not kept close to the vessel. If the accident occur, the surgeon must not persist in his attempt to tie the artery at this spot, a course which will only end in his inflicting more injury on the vein, but finger-pressure being made in the lower angle of the wound, the artery is tied either above or below the spot where the vein has been injured. As soon as the artery is secured, no further hæmorrhage will take place, but pressure may be kept up by means of a carbolized sponge over the wound for a day or two.* The patient will do well to wear a Martin's bandage or an elastic stocking for some time after getting up. 4. Including one of the nerves. 5. A matted condition of the parts due to a previous trial of compression.

Abnormalities of the Femoral Artery.

1. A double superficial femoral, the two trunks uniting below to form the popliteal. More than one case of this kind is recorded. The persistence of pulsation in the aneurism after the first ligature would lead to a suspicion of this condition. 2. The vessel may run down at the back of the limb.

LIGATURE OF FEMORAL ARTERY IN HUNTER'S CANAL (Fig. 184).—TREATMENT OF A STAB IN MID-THIGH (Fig. 183).

Indications for Ligature of the Femoral Artery in Hunter's Canal.

1. Wounds.—These may be, (*a*) incised; (*b*) punctured.

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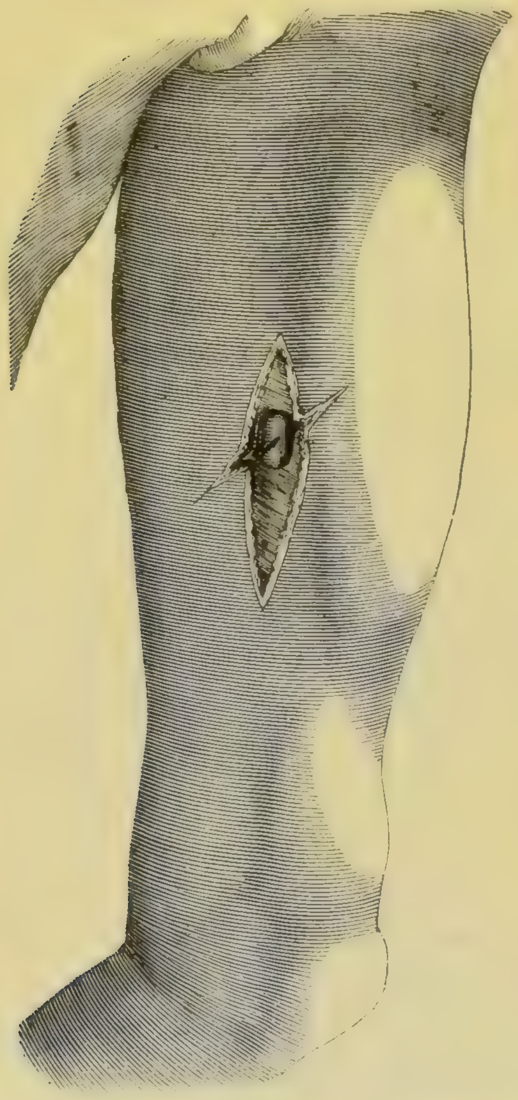
will be found of much help in cleaning the vessel if one edge of the cut sheath is held by an assistant, while the surgeon has hold of the other; the opening in the sheath is thus made sure of and retained. There must be no needless disturbance, or lifting up of the vessel upon the needle, which, with the director must be used with the utmost carefulness. As soon as the eye (and this should be at the very end of the needle) is seen to have passed round the vessel the ligature should be at once seized and the needle withdrawn.

* If venous hæmorrhage persist, the opening in the vessel should be secured with a chromic-gut ligature, or a pair of Spencer Wells's forceps left *in situ* (p. 464).

(*a*) Here, if immediate death from hæmorrhage has been arrested, the wounded vessel must be secured. The artery above being compressed by an Esmarch's bandage or the hands of an assistant, the wound is enlarged, clots sponged away, and the artery tied above and below the wound in it (Fig. 183). If the vein is found injured too severely for a laterally applied ligature, and requires ligature in the ordinary way, the patient or the friends must be prepared for the imminent need of amputation.

FIG. 183.



Incised wound of the thigh explored and found to involve the femoral artery. An Esmarch's bandage should have been shown *in situ* above.

(*b*) If a punctured wound lies in the line of the artery (p. 1056), and if much blood has been lost, the main trunk is probably injured, and the question will arise, if the bleeding has ceased, whether to cut down upon the artery or to trust to pressure. Mr. Cripps (*Dict. of Surg.*, vol. i. p. 525) advises that, if the wound be in the upper part of the thigh, "the surgeon may enlarge the wound with a good prospect of finding the wounded vessel without an extensive or prolonged operation. If the wound be in the lower half of the thigh, owing to the greater depth of the artery, and the possibility of its being the popliteal which is wounded, the search is rendered far more severe and hazardous, and it should not be taken until a thorough trial of pressure has proved ineffectual."

The following mode of applying pressure is taken from Mr. Cripps (*loc. supra cit.*).* I would also refer my readers to the account of punctured wound of the palm given at p. 19 of this work.

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* Mr. Cripps' account will be found under the heading of the treatment of secondary hæmorrhage from the femoral. He draws attention to the instructiveness of the literature of this subject, as it proves not only that many cases have been successfully treated by pressure from the first, but that both life and

The main vessel being controlled above, the foot and leg should be carefully strapped from the toes to the knee, and a bandage then carried from the toes up to the wound, and then, avoiding this, up to the groin, where it is secured, spica fashion, over a pad on the main artery. The limb is then laid on a long back splint with a foot-piece, and secured to this in an elevated position. The wound being cleansed and dusted with iodoform, a graduated compress (p. 19) is then fastened over it. Two rectal bougies are then applied in the course of the artery, above and below the wound, outside the bandage which surrounds the limb, so as to keep these segments of vessel empty. Two well-padded lateral splints are then secured with straps and buckles to the thigh. Morphia must be given as freely as is judicious.*

2. Hæmorrhage from a Stump after Amputation in the Lower Third of Thigh or Knee.—If clearing away the clots and disinfecting the stump, followed by well-adjusted pressure, and, this failing, trying to find the bleeding point in the flaps, do not suffice, the artery must be tied above.†

LINE AND GUIDE (p. 1056).

RELATIONS :—

IN FRONT.

Saphena vein.
Skin; fasciæ; sartorius; aponeurosis between vastus internus and adductors.

OUTSIDE.		INSIDE.
Vastus internus ; vein (slightly).	Femoral artery in Hunter's canal.	Adductor longus and magnus.

BEHIND.

Femoral vein (especially above).

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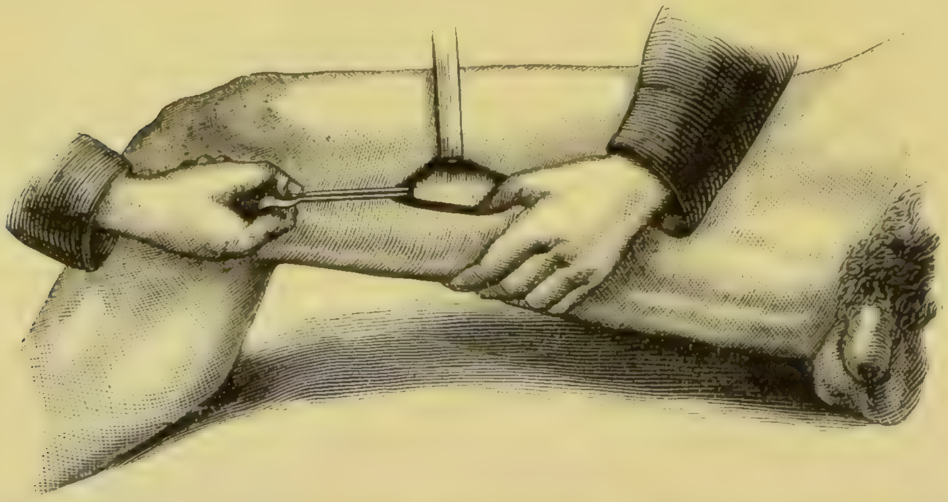
limb have been saved by pressure after the surgeon has failed to find the artery in the wound, or after the iliac has been tied in vain.

[*] Mr. Cripps advises that the limb should be slightly raised on a pillow, and partly bent at the knee and thigh. The toes should be left exposed that their condition may be watched.

[†] I would again refer my readers to Mr. Cripps' article (*loc. supra cit.*, p. 526). He points out that a decision between opening the flaps or ligaturing the main vessel high up must depend on the amount of union, and that if the flaps must be opened and the vessel sought for before there is much firm union, as in the first fortnight, a director should be used rather than a knife, and that if the vessel is found, its soft condition will require very gentle tying.

Operation (Fig. 184).—The knee and hip being flexed, and the limb abducted and rotated outwards, the surgeon, seated comfortably on the inner side of the limb, makes an incision 3½ inches long in the line of the artery in the middle third of the thigh.* The skin, superficial and deep fasciæ, being divided, and the saphena vein drawn to one side with a strabismus hook, and any of its branches divided between double chromic-gut ligatures, the sartorius is identified by the direction of its fibres and drawn to the inner side. The canal is next opened by dividing the aponeurotic roof, and the artery or its pulsation felt for. This vessel will be found closely connected with its vein, which lies behind it, while the saphenous nerve crosses it from without inwards. The artery being most carefully cleaned all round, the ligature may be passed from either side, as is found most convenient.†

FIG. 184.



Ligature of the femoral artery in Hunter's canal. The surgeon standing outside finds the furrow between the adductors and the quadriceps, and then makes an incision in the line given at p. 1056. The lower lip of the wound being depressed with the left thumb, the deep fascia is divided on a director. (Farabeuf).

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* This incision must not be made too low down. Its centre should correspond to the centre of the thigh.

† Much difficulty will be met with in tying the femoral artery in Hunter's canal unless the line of the artery (p. 1056) is strictly followed. A common mistake is to make the incision too far out, thus exposing the fibres of the vastus internus, which run downwards and outwards, instead of those of the sartorius, which run downwards and inwards (Smith and Walsham, *Man. of Oper. Surg.*, p. 83). Erichsen (*Surgery*, vol. ii. p. 250), who gives as the line of the artery, one drawn from a point exactly midway between the anterior superior spine and the symphysis pubis to the most prominent part of the internal condyle, insists on the need of making the incision a finger's-breadth internal to this. The line given above will be found sufficiently internal.

Causes of Failure after Ligature of the Femoral.

1. Gangrene.

2. Secondary Hæmorrhage.—If pressure fail, an attempt must be made to re-tie the vessel, and, this not succeeding, the limb must be amputated.

3. Suppuration of the Sac of an Aneurism.—This is very rare.

4. Recurrent Pulsation in the Aneurism.—The premature softening of catgut, especially in a septic wound, must always be remembered as a possible cause of this. Pressure failing, the artery may be tied lower down.

5. A very rare complication is the formation of an aneurism at the seat of ligature.

AMPUTATION THROUGH THE THIGH.

(Figs. 185–187.)

Practical Points in Amputation of the Thigh.—As the soft parts behind are more bulky than those in front, and as it is desirable to place the bone as near as possible in the centre of the soft parts, the back of the thigh, in the case of a bulky limb, may be supported by the hand of an assistant during the first introduction of the knife to form the anterior flap (Skey). Amputation should always be performed as low down as possible, not only to avoid shock and to secure as long a stump as possible for the artificial limb, but also to secure as much as possible of the rectus femoris. This muscle is a most important agent by which the thigh is put forward in stepping. Its division does not preclude the retention of its office, as it acquires a sufficient adhesion to the material of the stump to answer every useful purpose, as an agent in the flexion of the thigh on the pelvis, though that of extension of the leg be destroyed (Skey, *Oper. Surg.*, p. 391).

Different Methods.—The following five, which will give ample choice, will alone be described here; the first is especially recommended:—

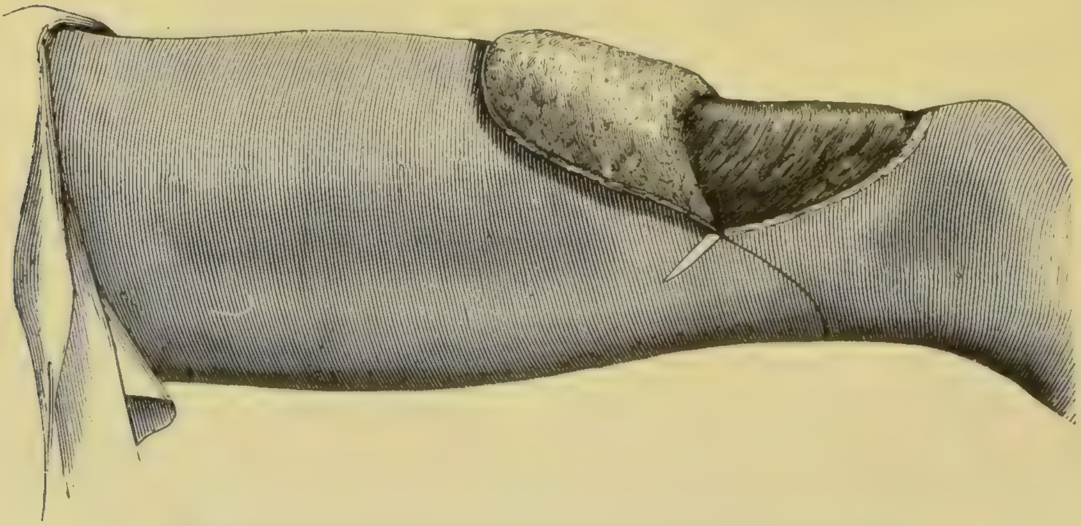
I. **Mixed Antero-posterior Flaps and Circular Division of the Muscles.** II. **Antero-posterior Flaps by Transfixion.** III. **The Circular Method.** IV. **Rectangular Flaps.** V. **Lateral Flaps.**

I. **Mixed Antero-posterior Flaps and Circular Division of the Muscles.**—By the term mixed is meant an anterior flap of skin and fasciæ raised from without, and a posterior one made by transfixion. The anterior is, wherever practicable, made the longer of the two.

This method has the following great *advantages*:—(1) The longer anterior flap falls well over the bone, and thus keeps the scar behind; (2) Being raised from without inwards, it can be taken from the neighbourhood of the knee-joint and patella; (3) It is a most expeditious method,* almost as quick as that by double transfixion flaps; (4) It is suited to all cases, save perhaps those of very muscular thighs, where the surgeon should be careful to take only part of the muscles behind as he transfixes, or else should raise his posterior flap also from without inwards; (5) It gives good drainage.

Operation.—The femoral artery being controlled with an Esmarch's bandage,† the limb being brought over the edge of the table, and supported by an assistant, who has bandaged the damaged or diseased part to give his hands a firmer grip, and to prevent their becoming septic; the opposite ankle being tied to the table, and the parts duly cleansed, the surgeon standing to the right side of the limb to be removed, places his left index and thumb on either side of the limb, at the level where he intends to saw the bone,‡ and sinking the point of his knife through the skin just below the former and rather below the centre of the outer or inner aspect of the limb, as the case may be, carries it rapidly down for about 4½ inches, and then sweeps it across the limb with a broad, not pointed, convexity, and carries it up along the side nearest to him as far as his thumb. This

FIG. 185.



The knife should have been inserted here from the inner side.

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* As in railway and other accidents.

† If the surgeon is amputating very high up, the method given in the account of amputation at the hip-joint (p. 1029) may be used.

‡ The finger and thumb should not be shifted till the anterior flap is marked out.

flap is then quickly dissected up of skin and fasciæ, and the knife, being sent across the limb, behind the bone, cuts a posterior flap almost as long as the anterior, the knife being used with a rapid sawing movement, and driven at first straight down parallel with the bone, and then sharply brought out through the skin.

The flaps being held out of the way with the surgeon's left hand,* the soft parts around the femur are next severed with circular sweeps † (p. 1070), till the bone is exposed, when one more firm sweep divides the periosteum.‡

The saw is now placed with its heel on the bone and drawn towards the operator once or twice with firm pressure so as to make one groove, and one only. With a few sharp sweeps the bone is next severed, care being taken to use the saw lightly for fear of splintering the linea aspera, and to use the whole length of the instrument. At this time the limb must be kept steady and straight, the assistant neither raising it, which will lock the saw, nor depressing it, which will splinter the femur when this is partly divided.

If the surgeon decide to make his posterior flap also of skin and fasciæ, he must have the limb raised, and first looking over and then stooping down, marks out a skin flap about $\frac{2}{3}$ the length of the anterior; this is then dissected up, and the operation completed as before.

In addition to the femoral vessels, the anastomotica, and descending branch of the external circumflex, some muscular branches will require attention; and one of these last may give some trouble from its position close to the bone in contact with the linea aspera.§

In amputations of the thigh accompanied by grave shock, no needless time should be lost in looking for vessels, save the femoral and any other large branch which can be seen. Firm bandaging and raising the stump will suffice. It is well to

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[*] And also pressed firmly upwards, so as to enable the saw to be applied as high up as possible. If the limb is bulky an assistant must help here.

[†] This requires really forcible use of the knife, the muscles behind the bone tending to be pushed before the knife rather than divided by it.

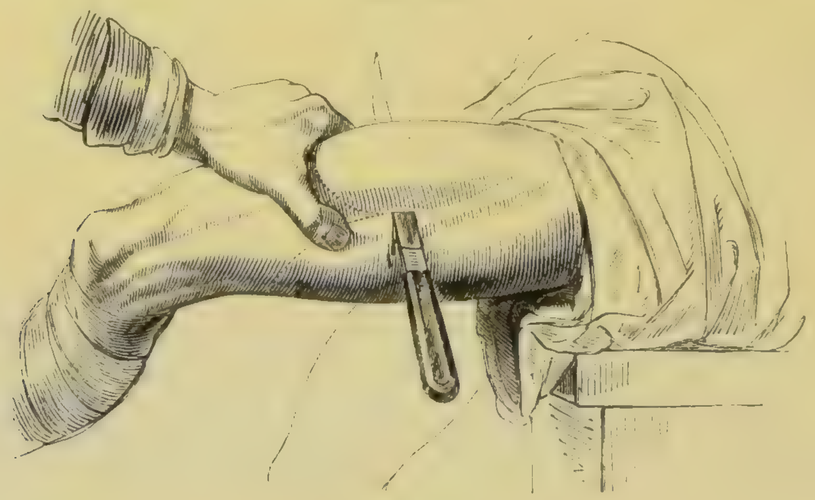
[‡] This final cut should be a little above the base of the flaps, in order that the sawn femur may lie well buried in soft parts.

[§] The following points deserve attention in tying the femoral vessels:—(1) Not to include the saphenous nerve; (2) the tendency of the vessels to slip up if the point of their division passes through Hunter's canal; (3) if the vessels are atheromatous they must not be tied too tightly. A carbolized silk ligature, not too fine, should be employed now, and care should be taken to include a little of the soft parts to prevent the ligature cutting through.

partially relieve the tightness of the bandaging in a few hours by nicking them. Very few sutures should be used in these cases of shock, or in those where the soft parts are sinus-riddled.

II. **Transfixion Flaps.**—*Advantage.*—Great rapidity. *Disadvantages.*—Those given at p. 47, on a large scale. This method may be used where great speed is needed, as in a double amputation after a railway accident, or where many wounded require attention, as after a great battle. It is also adapted to the wasted muscles of a patient who has long suffered from some chronic disease of knee or leg, but even here it is inferior to the mixed method.

FIG. 186.



(Fergusson.)

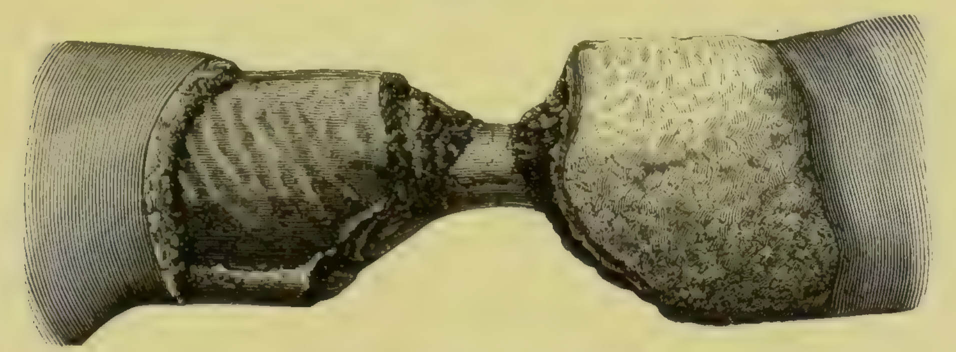
Operation.—The preliminary steps given at p. 1066 being taken, the surgeon, standing to the right side of either limb, with his left index and thumb marking the site of his intended bone-section, raises with his hand the soft parts on the front and sides of the thigh, and sends his knife across the limb in front of the femur. The knife should be entered well below, so as to get as large an anterior flap as possible, and, at its entry, should be pushed a little upwards so as to go easily over the bone. An anterior flap is then cut 4 to 4½ inches long, with a broadly curving almost square extremity, and not too thin at its edge. This being raised by the surgeon or an assistant, the knife is now passed behind the bone, and a posterior flap cut of the same length as the anterior, the making of this flap being somewhat facilitated by drawing the soft parts on the back of the limb away from the bone.

If the limb be very bulky, the knife should be kept well away from the bone, especially behind it, and not as at p. 1067; thus the more superficial muscles only will be included in the posterior flap.

Both flaps being retracted, the remaining soft parts are severed with circular sweeps, and the rest of the operation completed, as at p. 1067, but with this difference, that here there will be more need of trimming some of the soft parts clean and square.*

III. **The Circular Method.**—I may here state briefly why this method is, nowadays, considered inferior, both in the thigh and elsewhere, to that by flaps. In saying this, it is not denied that in many cases stumps by the circular method are fully equal to those by flaps; indeed, in many it is impossible to tell, in later years, which method has been employed. On the whole, however, the flap-method has the following advantages:—(1) It is most generally applicable—*e.g.*, in parts not circular and at the joints.† (2) By it the surgeon can better adapt his skin covering to his needs—*e.g.*, when the skin is less available on one aspect of the limb than on another. (3) There is less risk of a conical stump; and (4) of a cicatrix adherent to the bone. The great advantage of the circular method—viz., that the vessels and nerves are cut square, and that, thus, the former retracting more easily, fewer need securing, while there is less risk of bulbous ends forming on the latter, is attained by the mixed method of skin flaps and circular division of the muscles as at p. 1065.‡

FIG. 187.



Circular amputation of the thigh to show the greater retraction of the muscles behind.

The circular method is only to be adopted here in the case of the lower third of wasted thighs, or in those of young subjects.

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* While dresser to the late Mr. Poland, I once saw the femoral vessels split for about 3½ inches by his rapid hands. This amputation of the thigh was his last operation at Guy's Hospital. He was even then facing with quiet bravery the bronchitis which, a very few days later, ended his life.

† To these it may be added that the circular method is not adapted to a case where the skin is matted to the subjacent muscles.

‡ One more advantage of the flap method is the greater rapidity, especially when transfixion is employed, though this, in these days of anæsthetics, is only of importance in a few cases.

Even here the greater tendency of the posterior muscles to retract must be met by cutting them about ¾ inch longer than those in front.

While this operation is for the above reasons not recommended in practice, it may be made use of in the lower third of the thigh, in the cases mentioned above. On the dead subject the student who has not had a chance of performing it upon the arm may make use of it here.

Operation.—As this method has been described in detail at p. 91,* it will be only briefly given here. The preliminaries are those already given. The surgeon standing to the right of the limb, the assistant, who stands on the opposite side to him, but nearer the trunk, draws up the skin with both hands. The surgeon, stooping a little, passes his knife first under the limb, then above, across, and so around it till by dropping the knife vertically the back of the instrument looks towards him, while its heel rests on that side nearest to him. He then makes a circular sweep around the thigh, this being aided by the assistant who has charge of the limb, rotating it so as to make the soft parts meet the knife. The surgeon then taking hold of the edge of the incision dissects up a cuff-like flap, about 4½ inches in length, cutting it of even thickness all round the limb. The flap is then folded back, and the remaining soft parts divided with circular sweeps of the knife. In doing this, the greater contraction of the hamstring muscles must be remembered, and these muscles cut rather longer than those in front. Care must be taken, if it is thought needful, after making the circular sweeps, to free the bone higher up, and so to secure its being well buried in the soft parts, but not to prick the already divided femoral vessels which lie in close proximity to the femur in the lower third.

IV. **Rectangular Flaps of Mr. Teale.**—This method is fully described below. It is not recommended here as it is expensive, involving division of the bone nearer to the trunk than other methods. (1) Owing to the bulkiness of the long anterior flap, it is, here, especially difficult to fold and adjust it at the conclusion of the operation, and, still more so, to keep it adjusted if primary union fails. (2) Its chief advantages, that of keeping the end of the bone well buried, and of cutting the vessels and nerves clean and square, are also sufficiently attained by the other flap methods already given, especially the mixed method (p. 1065).

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* If it be objected that the plan here given of turning up a cuff-like flap is likely to lead to sloughing, I would reply that this is not so in these days of antiseptic surgery. If sloughing is dreaded, a little more time should be taken in dissecting up a thin layer of muscle, so as to secure the deep fascia, and thus a better vascular supply.

V. **Lateral Flaps.**—This method has certain grave objections here. (1) The sawn femur, tilted upwards by the ilio-psoas, is very liable to press against the upper angle of the flaps, and to come through at this spot and necrose. (2) If this does not take place, the bone often adheres to the cicatrix here, while the flaps hang down and away from it.

It should only be made use of when no other method is available, as in a case where, owing to the condition of the soft parts, flaps can only be got by making one long external and a short internal, or *vice versâ*.

Operation.—This method will be found fully described at p. 1123.

AMPUTATIONS IMMEDIATELY ABOVE THE KNEE-JOINT (Figs. 188–194).

Methods.

i. **Carden's** (Figs. 188–190). ii. **Gritti's Trans-condyloid** (Figs. 191, 193). iii. **Stokes' Supra-condyloid**, an important modification of the above (Figs. 192, 194).

All the above, but especially the two latter, possess the following *advantages* (which they share with amputation through the knee-joint) over amputation through the thigh, viz.:

1. The patient can bear his weight in walking on the face of his stump; thus, he is not compelled to take his bearing from the tuberosity of the ischium, or to walk as if he had an ankylosed hip-joint (Stokes), as is the case after amputation of the thigh, where the stump is ever liable to be fretted by the slightest pressure on it. 2. Very good power of adduction over the artificial limb remains. Every surgeon must have noticed how badly off a patient is in this respect after an ordinary amputation through the thigh. By these methods the adductors are left almost intact, even to part of the strong vertical tendon of the adductor magnus, the result being that the balance between the adductors and abductors of the thigh remains practically undisturbed, and the patient when walking has none of that difficulty (which is seen after thigh amputations) of bringing the limb which he has swung forwards in again, under the centre of gravity.* 3. The medullary canal is not opened; on this account there is

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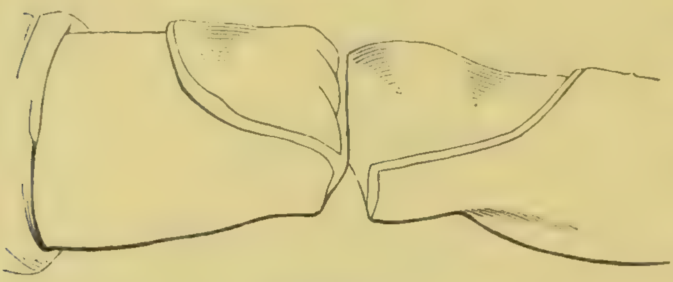
* The importance of the preservation of the quadriceps extensor, given by the Stokes-Gritti method, need only be alluded to.

less risk of necrosis and osteo-myelitis if the stump becomes septic. 4. There is less shock, because (*a*) the limb is removed farther from the trunk, (*b*) the muscles are divided not through their vascular bellies, but through their tendons.

FIG. 188.

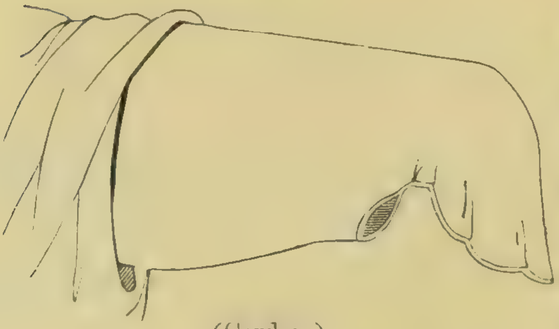


(Carden.)

i. Carden's Amputation (Figs. 188–190).

Advantages.—This valuable amputation has some points in common with Syme's amputation at the ankle-joint. In both the bone-section is made not through a medullary canal but through vascular quickly healing cancellous tissue; in both, the skin reserved for the face of the stump has been used to pressure, though not equally so, for the skin preserved in the ankle amputation is thick and callous, in the other thinner and more sensitive.

FIG. 189.



(Carden.)

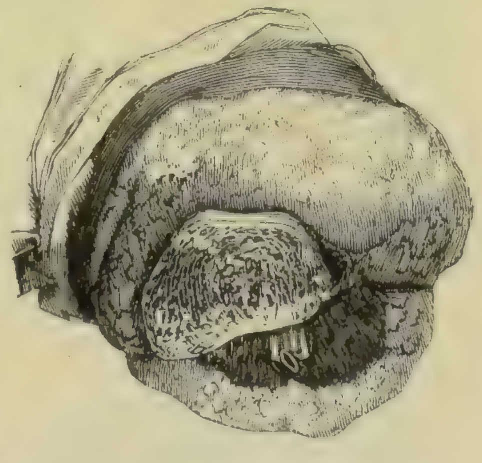
Sir J. Lister (*System of Surgery*, vol. iii. p. 705) thus recommends this amputation:—"This operation, when contrasted with amputation in the lower third of the thigh, presents a remarkable combination of advantages. It is less serious in its immediate effects upon the system, because a considerably smaller quantity of the body is removed, and also because the limb, being divided where it consists of little else than skin, bone, and tendons, fewer blood-vessels are cut than when the knife is carried through the highly vascular muscles of the thigh; the popliteal and one or two articular branches being, as a general rule, all that require attention, so that loss of blood is much diminished. In the further progress of the case the tendency to protrusion of the bone, which often causes inconvenience in an amputation through the thigh, is rendered comparatively slight by the ample extent of the covering provided, and also by the circumstance that the divided hamstrings slip up in their sheaths, so that the posterior muscles have comparatively little power to produce retraction. The superiority of the operation is equally conspicuous as regards the ultimate usefulness of the stump, which, from its great length, has full command of the artificial limb, while its extremity is well calculated for sustaining pressure, both on account of the breadth of the cut surface of the bone divided through the condyles, and from the character of the skin habituated to similar treatment in kneeling. Considering therefore that this procedure can be substituted for amputation of the thigh in the great majority of cases both of injury and disease formerly supposed to demand it, 'Carden's operation' must be regarded as a great advance in surgery."[*]

Disadvantages.—The chief of these is the sloughing of the long anterior flap which may occur, "in spite of faultless operating," especially if the skin, of which it chiefly consists, has been damaged by injury or disease, or if the patient be old or weakly, thus leading to an adherent, tender scar, and a useless stump.

Operation.—According to its introducer this amputation consists in removing a rounded flap from the front of the joint (Figs. 188–190), dividing everything else straight down to the bone, and sawing this slightly above the plane of the muscles.

The operator standing on the right side of the limb, takes it, between his left forefinger and thumb, at the spot selected for the base of the flap,[†] and enters the point of his knife close to his finger, bringing it round through the skin and fat below the patella to the spot pressed by his thumb, then turning the edge downwards at a right angle with the line of the limb, he passes it through to the spot where it first entered, cutting outwards through everything behind the bone. The flap is then reflected, and the remainder of the soft parts divided straight down to the bone; the muscles are then slightly cleared upwards, and the saw applied "through the base of the condyles." The projecting part of the femur may

FIG. 190.



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[*] Other advantages given by Mr. Carden are, the favourable position of the stump for dressing and drainage; its painlessness, the chief nerves being cut high up out of reach of pressure; and the cicatrix being drawn clear of the point of the bone, and out of reach of pressure.

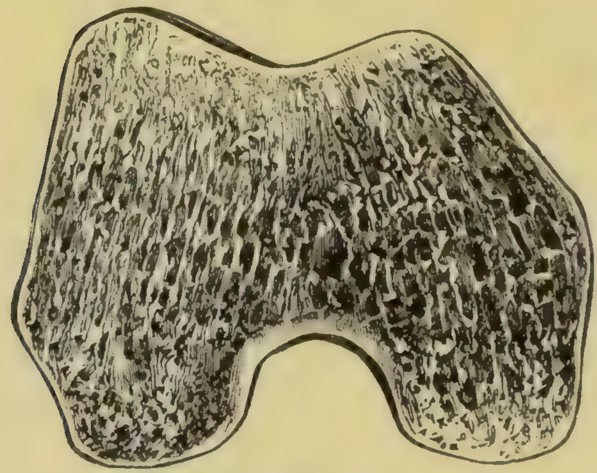
[†] This corresponds with the upper border of the patella, the limb being extended. The lower margin comes down to the tubercle of the tibia, as in fig. 188. See also *Brit. Med. Journ.*, 1864, vol. i. p. 416.

be rounded off. Where there is any doubt about the vitality of the large anterior flap, a short posterior one should be made, the anterior one thus not needing to be so long (Fig. 190).

ii. **Gritti's Trans-condyloid.** iii. **Stokes' Supra-condyloid Amputation** (Figs. 191–194).

For fuller information on the above amputations I would refer my readers to a paper I contributed to the *Guy's Hosp. Reports*, vol. xxiii. p. 211, 1878. The objections to amputation through the knee-joint, whether by a long anterior, or long posterior flap, are given at p. 1079. Amputation through the knee-joint by lateral flaps gives excellent results, but in this method the incisions are carried into the leg below the tibial tubercle; in the two amputations mentioned above this level is not trenched upon, and every surgeon knows that after a severe compound fracture of the leg, an inch or two more or less of damage to the soft parts in the upper third of the leg makes a most important difference as to where he can amputate.

FIG. 191.

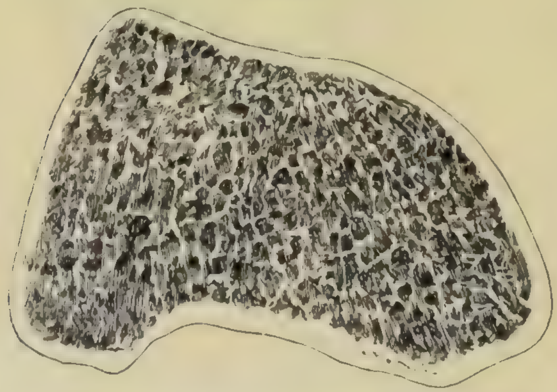


Gritti's trans-condyloid section of the femur, leaving a surface much too large for the sawn patella to fit.

The two methods are often confused. Between them there is this all-important difference: in Gritti's, the section of the femur is made *through* the condyles; in Stokes', at least ½ inch *above* them. In other words, the one operation is *trans-*, the other *supra-condyloid*.

On this point great stress has been laid, and very rightly, by Sir W. Stokes, and a comparison of the two operations will convince every one that he is correct. If the section of the femur be made through the condyles (Figs. 191, 193), the sawn patella will not fit down into place. It will either be drawn up altogether on to the front of the femur, or else will

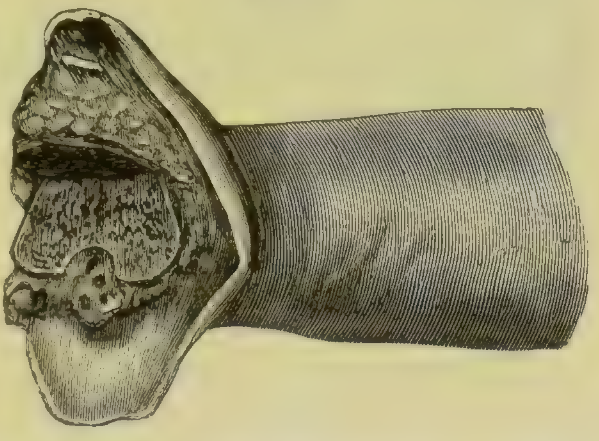
FIG. 192.



Stokes' supra-condyloid section of the femur, leaving a surface much more easily fitted by the sawn patella.

project forwards, somewhat like the half-open lid of a box, at an angle to the broad sawn surface, which is also too large for it to cover, and across, and off which it is liable to be shifted by the contraction of the quadriceps, if it has been found possible to get it into place. To effect this, an amount of force will be required which is almost certain to result in bruising of the cut periosteum on the edge of the femur, and consequent necrosis. If, on the other hand, the saw is made to pass ½ inch *above* the condyles (Fig. 192), the patella will fall readily into place, it will cover more completely the now smaller sawn surface of the femur, and will remain easily *in situ* here, the flaps when brought together presenting the appearance shown in Fig. 194.

FIG. 193.

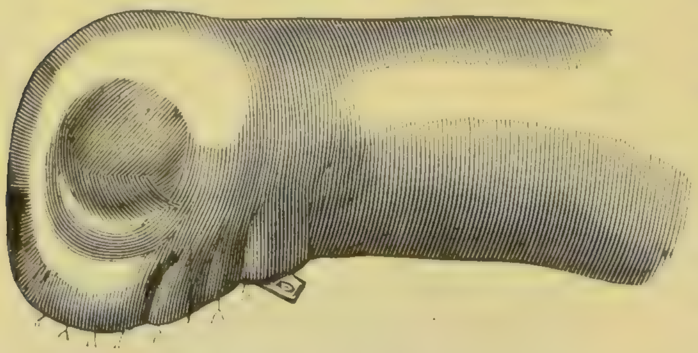


The flaps in Gritti's trans-condyloid amputation, showing the patella hitched and requiring force to adapt it to the femur, which is now too long as well as too broad.

Operation. — An Esmarch's bandage being applied, the limb brought over the edge of the table and supported, and the opposite one secured out of the way, the surgeon standing to the right of the limb, with his left index and thumb marking the base of his flap, makes an incision commencing (on the left side) an inch above and rather behind the external condyle, carried vertically downwards to a point opposite to the tibial tubercle, then broadly curved across the leg and carried upwards to a point opposite to that from which it started. This flap, having been dissected upwards, together with the patella (after severing the ligamentum patellæ), a posterior flap is cut nearly as long as the anterior. This may be effected in one of two ways, either by the surgeon looking over and then stooping a little (the limb being now raised), next drawing the knife from without inwards across the popliteal space, thus marking out and then dissecting up a skin flap, or by transfixing and cutting the flap from within outwards. Of the two I prefer the first; the latter is the speedier, but less suited to bulky limbs. The flaps being retracted, the soft parts are cut through with a circular sweep ½ inch above the articular surface of the femur, the bone is then sawn through here, and the limb removed. The posterior surface of the patella is next removed with a metacarpal- or small Butcher's-saw. This last step is the only difficult one in the operation, owing to the mobility of the bone; it will be facilitated by an assistant with both his hands everting and projecting the under surface of the anterior flap, so as to make the patella stand out from it.

The vessels—popliteal, one or two articular and the anastomotic—having been secured, drainage is provided, and the flaps are brought together with numerous points of suture, save at the angles (Fig. 194).

FIG. 194.



Appearance of the stump in a Stokes' Gritti's amputation. The patella has come easily into place.

Where the flaps are cut of proper length and the femur is sawn at the proper height, it is quite exceptional for the patella not to ride easily *in situ*. If there seem any doubt on this point, or if the patient is very muscular, additional security may be given—(*a*) By passing sutures of chromic gut or carbolized silk between the tissues on the under surface of the anterior flap, at the edges of the patella, and the soft parts in the posterior flap (avoiding the vicinity of the large vessels); (*b*) by wiring or pegging the bones; (*c*) by dividing the rectus muscle on the under surface of the anterior flap. Of these, wiring or pegging is the best; the pegs must be scrupulously clean. They should be well boiled beforehand in a solution of hyd. perch. An ordinary bradawl, also rendered aseptic, will be found quite as efficient as a drill.

REMOVAL OF AN EXOSTOSIS FROM NEAR THE ADDUCTOR TUBERCLE.*

As these growths are by no means uncommon in adolescents, this operation will be briefly described here. Aseptic excision has now replaced any other operation such as subcutaneous fracture.

Operation.—The parts being thoroughly cleansed, the knee is flexed so as to bring down the synovial membrane, and the limb placed on its outer side. A free incision, about 3½ inches long, is made over the growth, down to the vastus internus, and any superficial vessels attended to. The muscular fibres are then cleanly cut through,* and the bluish-grey cartilage which caps the swelling now comes into view.† Any muscular branches being now carefully secured, and the wound sponged dry, the cut vastus is pulled aside with retractors, and the growth being thoroughly exposed it is shaved off with an osteotome or chisel, leaving exposed cancellous tissue. A little iodoform is dusted in, and drainage provided by a tube or large horsehair drain, passed from the wound to the most dependent spot on the inner side, the dressing-forceps passing under the muscle and being cut down upon by counter-puncture, where they project under the skin. The muscular fibres are then united with chromic gut, cut short, and the wound closed with separate sutures. Strict aseptic precautions are taken throughout to secure primary union. The limb should be kept absolutely quiet on a back splint, and a Martin's bandage worn, later, for a short time.

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* This account will serve for the removal of other exostoses—*e.g.*, that met with at the deltoid insertion.

UNUNITED FRACTURE OF THE FEMUR.

The large number of failures after operations for this condition are well known. The difficulties which may be present during and after these operations are very considerable; amongst them sufficient exposure of the fragments, and keeping the wound aseptic, are most prominent.

Operation.—On the whole, the introduction of pegs having been less successful, sub-periosteal resection of the fragments is indicated here.‡ This is especially so in long-standing cases, where other methods have failed, where there is very little attempt at repair, where an artificial joint exists, or where, after a severe injury, necrosis, atrophy of the fragments, and fibrous union have followed.

The operation of resection should always be performed with strict aseptic precautions, otherwise the risks of suppuration, erysipelas, osteo-myelitis, and pyæmia, owing to the very free incision required, the exposure of cancellous tissue, and, perhaps, of the medullary canal, are considerable.

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* This is more likely to conduce to primary union than tearing them through with a director.

† Any synovia-like fluid now escaping comes probably from a bursa over the growth, not from the joint.

‡ Sir J. Lister has recorded (*Brit. Med. Journ.*, August 26, 1871) the case of an ununited extra-capsular fracture of the femur in a man aged forty-five, where, eighteen months after the injury, he cut down on the fragments, with antiseptic precautions, and gouged them, the fracture being then finally put up. Recovery was complete, the man walking well.

The limb having been rendered bloodless, if practicable, with Esmarch's bandages, the fracture is exposed by a free incision, 5 to 6 inches long, on the outer side of, and going down to, the bone. The periosteum is next most carefully detached from the ends of the fragments, and a thin layer of bone, about a $\frac{1}{4}$ inch in thickness, removed from each. To facilitate the resection, the fragments may be thrust out of the wound, or, after the removal of the periosteum, dragged out and steadied with sequestrum-forceps before the saw is applied. The soft parts must be protected with spatulæ and retractors while the ends of the bone are removed with a narrow-bladed saw. The fragments are now brought into exact apposition, and to facilitate this it may be necessary to divide adhesions or to remove any intervening fibrous or fibro-cartilaginous material, or a sequestrum. The ends are now to be drilled, the drill being entered on the superficial surface of each fragment, and then made to project in the centre of the medullary canal. They are next held together by passing very stout * silver wire through the drill-holes, and twisting this up. If the wire is to be removed three or four half-twists or two complete twists should be sufficient. If the surgeon prefer he may hammer it down, *in situ*, having made three half-twists and cut the ends short. See the remarks, p. 1104. Sutures are best dispensed with so as to allow of free drainage. The after-treatment is that of a compound fracture.

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* About $\frac{1}{10}$ inch in thickness, so as to withstand the strain of the muscles of an adult thigh.

CHAPTER III.

OPERATIONS INVOLVING THE KNEE-JOINT.

AMPUTATION THROUGH THE KNEE-JOINT.—EXCISION OF THE KNEE-JOINT.—ARTHRECTOMY OF THE KNEE-JOINT.—WIRING THE PATELLA.—REMOVAL OF LOOSE CARTILAGES FROM THE KNEE-JOINT.

AMPUTATION THROUGH THE KNEE-JOINT (Fig. 195).

Chief Methods.

I. **By Lateral Flaps.** II. **By Long Anterior and Short Posterior Flaps.**—Of these the first is far the superior. The great objection to the second is, that in order to get sufficient covering to fall readily over the large condyles, a long anterior flap must be cut; as this must reach 2 inches below the tibial tubercle, a good deal of its blood-supply comes from below—*e.g.*, the recurrent tibial must be cut off and the flap is thus liable to slough. This risk is much diminished, and the blood-supply better equalized, by the method of lateral flaps.

I. **Amputation by Lateral Flaps.**—This, the method of Dr. Stephen Smith,* was brought before English surgeons by Mr. Bryant.† The femoral being controlled, the limb supported over the edge of the table, and slightly flexed, the surgeon standing on the right side of either limb marks out two broad lateral flaps as follows:—His left index finger and thumb being placed, the former over the centre of the head of the tibia, the latter at the corresponding point behind, opposite the centre of the joint, he marks out (in the case of the right limb) an inner flap by an incision which, commencing close to the thumb, is carried down along the back of the limb for about 3½ inches, and then curves upwards and forwards across the inner aspect of the leg, till it ends in front just below the index finger.‡ The knife not being taken off, a similar flap is then shaped from the outer side, but in the reverse direction. Dr. S. Smith calls attention to the following points:—In making these flaps, they should be cut broad enough to secure ample covering for the condyles, and the inner one should be made additionally full as the internal condyle is longer than the external. The flaps should be at least 3½ inches long, if of equal length. They consist of skin and fasciæ. When they have been raised as far as the line of the articulation the ligamentum patellæ is then severed, allowing the patella to go upwards. The soft parts around the joint are then cut through with a circular sweep, and the leg removed. In doing this, the limb being flexed to relax the parts and facilitate opening the joint, the semilunar cartilages will very likely be found closely encircling the condyles of the femur. Mr. Bryant, in the paper already quoted, and Dr. Brinton (*Philad. Med. Times*, Dec. 28, 1872), as long ago as 1872, have strongly advised that the semilunar cartilages should be left *in situ* by severing the coronary ligaments which tie them to the tibia. They thus, in Dr. Brinton's words, form "a cap, fitted on the end of the femur, which preserves all the fascial relations, effectually prevents retraction, and guards against the projection of the condyles."

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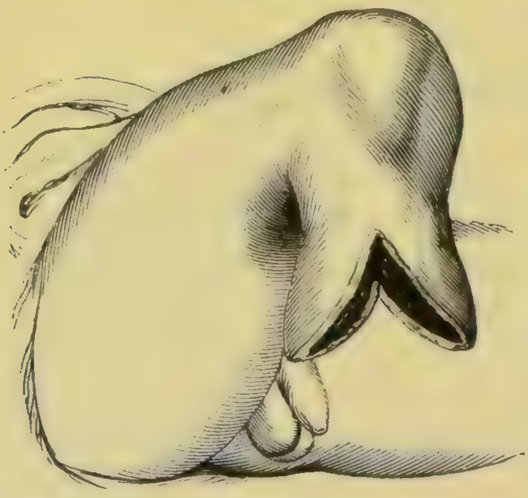
* *New York Journ. of Med.*, Sept. 1852; *Amer. Journ. Med. Sci.*, Jan. 1870.

† *Med.-Chir. Trans.*, vol. lxix. p. 163.

‡ Dr. S. Smith begins his incision about 1 inch below the tubercle of th

FIG. 195.



Amputation through knee-joint by lateral flaps. (Bryant.)

Mr. Pick's (*Med. Soc. Proc.*, vol. vii. 1884, p. 134) modification of the above operation is twofold—viz., (1) He begins his incision higher up—*i.e.*, at the upper border of the patella; and (2) he removes the patella. This last would appear likely to run the risk of damaging the blood-supply.

II. **By a Long Anterior and a Short Posterior Flap.**—The position of the patient and the surgeon being as at p. 1079, the latter with his left index and thumb on either side of the interval between the femur and tibia, enters his knife (in the case of the right limb) just below the finger and internal condyle, carries it straight down along the inner side of the leg till it reaches a spot

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tibia, and carries it up rather higher behind—viz., to the centre of the articulation. It will be found easier to open the joint and to detach the semilunar cartilages from the tibia by making the incision as recommended above.

2 inches below the tibial tubercle,* then squarely across the leg till it reaches a corresponding point well back upon the outer side, and thence up to a point just below his thumb, or to the external condyle. This flap is then dissected up, containing the patella, as thickly as possible, and almost rectangular in shape, anything like pointing of its lower end being most carefully avoided, as certain to lead to sloughing.

This flap being raised, a posterior flap is made about two-thirds the length of the first, as at p. 1075, either by dissection from without inwards, or by transfixion after disarticulation.

EXCISION† OF THE KNEE-JOINT

(Figs. 196–200).

Indications.—A. For Disease. B. Injury.

A. (i.) Pulpy. Tubercular knee.

This condition, being the most frequent indication for excision of the knee, calls for most careful consideration of the following points:—

(1) *Safety and Amount of Risk.*—Sir J. Lister's treatment, by removing sepsis, has rendered excision of the knee absolutely safe in properly selected cases. No surgeon who is familiar with careful antiseptic treatment and excision of the knee will say that the above is too strong a statement.‡ Excision here contrasts very sharply with the same operation at the hip, from the much greater facilities for getting away all the disease at the time, and for getting at and examining the wound later, together with the greater ease with which the wound here is kept aseptic.

(2) *Age.*—Here the operation has to be considered—(*a*) as a substitute for amputation; (*b*) as a substitute for the expectant

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* Mr. Pollock (*Med.-Chir. Trans.*, vol. liii. p. 20) advises that the anterior flap should reach "quite 5 inches below the patella." It is difficult to see how sloughing can be avoided here, so much of the blood to this very long flap coming from below and being of necessity cut off.

† This operation is contrasted with arthrectomy of the knee at p. 1099.

‡ I may perhaps say here that I have excised the knee sixty-three times, and performed arthrectomy on five occasions. Of these three died of effects of the operation, one (mentioned below) from shock, another (also mentioned below) from threatening gangrene, and another from surgical scarlet fever. This child was moved, during my absence from town, into an empty, chilly ward; the eruption became dusky and then suppressed; coma, followed by death, ensued. Four have been submitted to amputation, making good recoveries. This number would probably have been five, as a patient, aged fifty-three, whose knee had been excised for disorganization after osteo-arthritis and whom I had advised to submit to amputation, went out able to walk a little with a stick, but with two sinuses.

treatment. While incision may be successfully employed at any age up to thirty, and even occasionally in older* patients, I consider the most favourable years to be from about fifteen to twenty. Before fifteen, and particularly before ten, we have especially to consider the effect of the operation on the growth of the bone; after twenty we have more and more to consider the condition of the patient, the state of the viscera, general vitality, &c. I would ask my reader's careful attention to these points—(1) that the chief growth of the femur takes place at its lower end (p. 1042); (2) that by fifteen, and still more by seventeen, the growth of the bone is largely completed. It follows from the above remarks that in young subjects especially before ten, as little of the bones as possible should be removed, and that gouging should largely replace the saw (p. 1098).

(3) *Rank of Life.*—Excision of the knee being almost unknown in private practice, it is needless to remark that this account of the operation refers almost entirely to hospital patients. Let me briefly, though imperfectly, depict the usual fate of these patients with pulpy knee *if not excised early.* Bandied about from one out-patient room to another, treated more or less imperfectly with splints and strapping, frequently recommended for admission that they may obtain that "rest" which can nowhere else be carried out, at last the "dresser for the week," or surgeon, takes pity on the case and it is admitted. With what result? As soon as the inflammation has subsided and the pain has ceased, the child is thought to be occupying a bed which can be better employed for clinical teaching, and, after a few weeks' rest in bed, is turned out again, perhaps in plaster-of-Paris or a Thomas's splint. A little later, in the rough-and-tumble life of the courts and alleys of our large towns, the joint is wrenched, and the good gained is all undone. Suppuration now sets in at one or more points of the pulpy tissue, sinuses form, the ends of the bone become carious, and the condition of the joint from the now advanced stage of the disease, and its probably septic condition, is rendered far less favourable for any operation than it was at an earlier stage. Speaking briefly, believing, as I do, that in this rank of life excision will be needed in nine cases out of ten, I am of opinion, most distinctly, that, as soon as a pulpy condition is declared, excision or erasion (or perhaps both, combined) should be performed while the state of the joint and the general condition of the patient are, alike, favourable.

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* See the remarks on osteo-arthritis (p. 1084).

(4) *Value of the Limb.*—This *quæstio vexata* of thirty years ago is now largely settled. Very few will, nowadays, be found to dispute which is most serviceable, a limb though much shortened with a natural foot, or an artificial leg, especially of the kind supplied to hospital patients after amputation of the thigh. On this subject some remarks of Mr. Holmes (*Surg. Dis. of Children*, p. 497) may be quoted: "Even if we allowed that a patient, after successful excision of the knee, could only walk as fast and as far as some with a good artificial limb after amputation, this would still leave the operation of excision, in my mind, far the superior one, since the former patient can do by his own force, without any preparation and without any expense, what the latter can only do by the aid of the instrument-maker. I need hardly say, however, that this is a gross understating of the case. A patient after excision of the knee can often walk nearly as fast and nearly as far as he could before. The patient after amputation of the thigh, however well the case may have done, can rarely bear the fatigue of carrying the artificial limb many miles together, nor can there be any reasonable comparison of the agility of the two—at least in those cases where the foot, after excision, comes nearly on to the ground, and is in good position." As to those cases where the limb is flail-like and its growth seriously arrested, I would point out that they should hardly ever occur, with the improved treatment of wounds, the greater facilities with which a stiff apparatus of a simple kind can nowadays be supplied, our more exact knowledge of the epiphyses, and the substitutes for the saw which are ready to our hands in the shape of sharp spoons (p. 1101). I may also refer my readers to Sir W. Fergusson's Hunterian Lectures, Lecture VI., and his arguments in favour of a much-shortened limb over any artificial one.*

(5) *Condition of the Patient.*—I may refer my readers to the remarks on this point on excision of the hip, p. 1042. There is the same need here for examining for any evidence of lardaceous disease, or tubercular mischief, elsewhere, and to remember how latent and insidious these may be. Bone mischief elsewhere is not necessarily prohibitive. Three out of my sixty-three cases (p. 1081) had had spinal disease, well marked bosses remaining in all.

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* Mr. H. Lee (*Lancet*, 1888, vol. i. p. 769) publishes the results after twenty years of two cases of excision in boys of twelve and seven. In the first the leg was 9 inches, in the second 6 inches shorter than its fellow. Both patients had perfect use of the muscles of the leg and foot, and could walk all day with a light iron patten attached to a boot.

Each of them made an excellent recovery. Strumous disease of the tarsus existed in two others, and was cured by the time the knee was well. In two, disease of the hip co-existed on the same side; in one the limb had eventually to be removed by a Furneaux Jordan's amputation, the child recovering; in the other (the disease being on the opposite side) the knee after a trans-patellar excision did excellently, the hip disease being cured by rest.

(6) *Stage of the Disease.*—I have already shown (p. 1082) that I am a strong advocate for early excision in hospital cases, believing that, with the usual treatment, short of this, pulpy disease goes on, as a rule, inveterately from bad to worse. But in early life excellent results may be obtained in advanced cases, with sinuses and caries, if only all the diseased and septic material is got away.

(ii.) Threatening disorganization of the knee, with caries, after pyæmia, rheumatic fever, &c.

(iii.) Osteo-arthritis.—Where one joint only is affected, and the patient is not past middle life, excision gives good results. The surgeon must be prepared for sawing very dense bones.

(iv.) Ankylosis.—I think excision should be abandoned here for the far better operation of dividing, with aseptic precautions, the union, with an osteotome introduced first on one side and then on the other, and worked forwards under the patella, and skin, and backwards as far as the popliteal artery allows. If this fail, a double osteotomy of the femur and tibia should be performed rather than excision, an operation which, in the case of true bony ankylosis, is liable to be severe, prolonged, and to leave a large wound, and, in the case of young subjects, to lead to further shortening of a limb already atrophied and weakened from disease. As I shall not have space again to refer to this matter of ankylosis of the knee, I would strongly urge caution in rapidly and completely straightening a knee-joint which has long been the seat of a bony ankylosis in a bad position. My attention was drawn to this matter in a painful way about seven years ago. A girl of nineteen had been admitted under my care with bony ankylosis of the knee at a right angle, dating to disease seventeen years before. Finding that I was unable to materially improve the position by subcutaneously sawing through the bony union, I excised the joint and straightened it completely. The foot and leg remaining cold, an anæsthetic was given next day, and the limb put up flexed. The mischief was, however, done. The coldness remained, all pulsation in the tibials stopped, and gangrene evidently threatening, the thigh was amputated, the patient sinking afterwards.*

Post mortem, osteophytes were found on the posterior border of the tibia projecting backwards, and it was evident that over these, when the limb was straightened, the popliteal vein, a very small one, had been stretched and closed. Another most serious risk of at once straightening a contracted knee is tetanus, from stretching of the contracted popliteal fascia and the popliteal nerves.

(v.) Old, Neglected Infantile Paralysis.—Excision of the knee seems to me to be perfectly justifiable here, with a view of giving a firm support in the case of a limb useless from its flail-like, distorted state. I speak here of hospital cases, which furnish those miserably crippled lives which are still seen from time to time going the round of the hospitals. I have tried it in one case, where the result is good, the knee having healed with one dressing, but the child is still under treatment for the paralytic talipes of the ankle, and paralysis of one upper extremity. I followed in this my old friend G. A. Wright, of Manchester, who in the abstract of cases treated in the Pendlebury Hospital, 1884, records† the result of a case—a girl, aged fourteen—in which he had successfully excised the knee and ankle in such a case.

B. INJURY.—Here such injuries as those from gunshot and those from a lacerated wound or a compound fracture, must be considered separately.

1. Gunshot.—"The results of the excisions of the knee-joint, performed during the late civil war, whether the operations were primary, intermediary, or secondary, were not very encouraging, forty-four of the fifty-four cases in which the issues were ascer-

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* Just after this another London surgeon published a very similar case. Sufficient attention has not been drawn to this matter. It would have been much wiser on my part, with such dense and old-standing ankylosis, not to have attempted complete straightening at once, but to have straightened partly with an osteotome at first, and then to have completely rectified the position later. I have adopted this mode successfully since, on a much older patient, with almost as much contraction.

† The knee excised in 1883 was, a year and a half later, sound, straight, and well. The ankle remaining very weak, was excised, December 1884, by a transverse incision. The bones were soft and fatty, and could be cut with a knife. The tibia and astragalus were joined with stout silver wire, the ends being twisted and knocked down; the tendons were sutured with catgut. The wound was healed in less than a month. Measurement on January 12, 1885, showed 2¼ inches shortening as the result of the two excisions; the ankle excision did not appear to have perceptibly shortened the limb, while there is 1¼ inch less shortening than before the excision of the knee. No doubt the limb had grown with the increased power and use in it. February 1885: The child could now walk across the room upon the leg.

tained having terminated fatally, a mortality of 81·4 per cent., exceeding the mortality of the amputations of the thigh (53·8) by 27·6 per cent." (Otis, *loc. supra cit.*, p. 419). Sir T. Longmore (*Syst. of Surg.*, vol. i. p. 565) lays down these definite rules: "From all the experience which has been gained regarding gunshot wounds in which the knee-joint has been opened, especially if the surfaces of the bone have escaped damage, as may occasionally happen with modern narrow rifle bullets, and even in other cases where one of the bones have been fissured, or partial fracture has occurred, provided early immobilization of the injured parts can be secured, antiseptic treatment carried out, and the general surroundings are sufficiently hygienic, it may now be laid down as a rule that conservative treatment ought to be adopted. When, however, the circumstances under which the wounds have been inflicted are such that the precautionary measures and modes of treatment mentioned cannot be put into practice, when the patients are liable to be moved frequently or to long distances hurriedly, and without adequate protection, or when the joint is not only penetrated, but the surrounding coverings are much lacerated, or the bones are comminuted and the fragments completely detached, the sacrifice of the limb by amputation above the joint is the only measure calculated to afford a fair promise of safety of life to the patient."

2. Injuries other than Gunshot.—Excision is rarely practicable here. A very careful consideration of the local and general conditions present is needful. Amongst the former, damage limited to the articular surfaces, but little splintering of the shafts of the bones, an intact condition of the soft parts behind the joint are absolutely essential. No less important is it to weigh the more general points connected with the patient—viz., his age not reckoned by years only, the condition of his viscera, and his habits; all these points are attended to in the account of "The Treatment of Compound Fractures," given later on.*

Operation.†—The more I perform this operation, the more do I feel the truth of the words of Prof. Bruns, of Tubingen, that, while formerly its chief object was to remove all dead bone, it should now be considered of chief importance to remove all the granulation-material that can possibly be got away, and that the surgeon should not content himself with snipping away all he can, leaving the rest to caseate or become scar-tissue if it will, but pursue it with the same earnest aim of extermination as he would in the case of malignant disease. I would not by the above seem to speak slightingly of the value of securing healthy and correctly sawn surfaces of bone, as on these largely depends firm ankylosis and a sound and useful limb, but I would insist on the fact that such surfaces are secured in vain if pulpy material is allowed to remain, and that it is not as yet sufficiently recognised that other instruments—*e.g.*, sharp spoons and scissors curved on the flat—are, to the full, as useful as the saw.

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* An interesting case has been published by Mr. Atkinson (*Brit. Med. Journ.*, 1883, vol. ii. p. 70) in which, eleven weeks after a separation of the lower epiphysis of the femur (simple) with displacement, excision was performed. The patient, a lad of fifteen, recovered, but the report is only carried up to two months after the operation.

† Before and throughout an excision of the knee the operator should bear in mind the following points:—(1) To remove every atom of the disease; (2) to secure good drainage; (3) to leave the bones in good position; (4) to ensure absolute immobility afterwards; (5) to watch for and at once attack any relapse.

Before the time of the excision, any flexion of the knee should be corrected as far as possible by careful weight extension. A knee should never be excised while flexed. Such a step will not only be liable to lead to removing bone needlessly in order to straighten it, but stretching the contracted deep fascia and nerves may lead to tetanus (p. 1085). The risk of gangrene has also been already mentioned (p. 1084).

The parts being duly cleansed, and an Esmarch's bandage * applied at mid-thigh, the limb † is brought over the edge of the table, flexed, and held by an assistant as in Fig. 198.

From the moment of commencing the operation to its very close the surgeon must bear in mind the inveteracy of tubercular pulpy material (malignancy would probably not be too strong a word), and in his endeavours to extirpate the disease completely, both in the soft parts and in the bones, his operation must often combine the operations of erasion and excision.‡

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* Some object to the bandage as needless and as likely to lead to troublesome oozing after the operation. This may be met by firm pressure and even bandaging on of the dressings, so as to distribute any oozing evenly throughout them. If an Esmarch's bandage is not applied, the bleeding during the operation interferes with the removal of diseased tissues, requires constant pressure to arrest it, and taxes the patient's resources considerably. Its use meets another risk, which is possibly hypothetical, and that is, it renders impossible the general diffusion of tubercular material by the cut veins and lymphatics. Two Esmarch's bandages must not be applied if there is any risk of rupturing a pulpy capsule, or where the capsule has given way and septic sinuses exist.

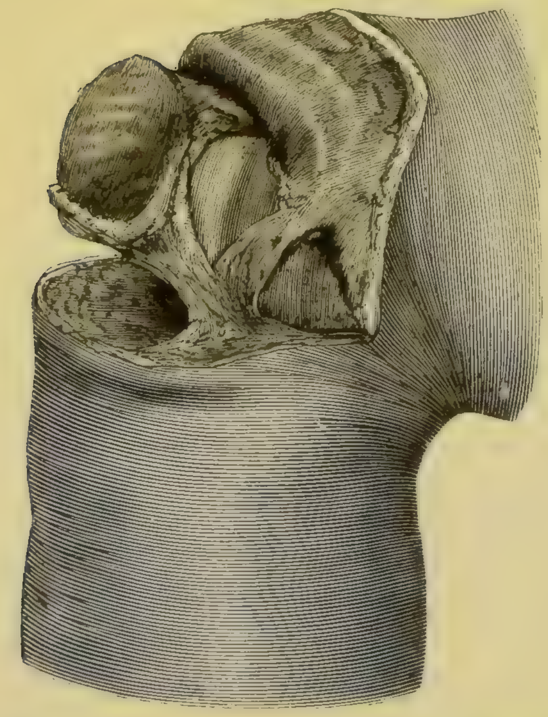
† Before the operation the area of incision should be thoroughly cleansed; the foot and lower leg should be well wrapped up in cotton wool, a heel-stirrup being applied if there is likely to be a sore heel. This is nailed to the foot-piece.

‡ If operations for pulpy knee are resorted to at an earlier stage in hospital patients, the bones will less and less need interfering with.

The following modes of exposing the joint will be given here :— A. **Transverse, Removing the Patella.** B. **Transverse, through the Patella.** C. **The Semilunar Flap** (lately recommended by Mr. Barker, and attributed by him to Moreau).

A. **Transverse, Removing the Patella** (Fig. 196).—This, the older method, is still resorted to by those surgeons who, like Mr. Howse, believe that, if the patella is retained, a most serious risk is run of leaving behind pulpy material which will require removal later on under less favourable circumstances, and, this failing, may lead to amputation.

Fig. 196.



The surgeon, standing on the left * side of the diseased knee (the opposite limb being tied to the table), makes an incision right across the joint from the back of one condyle to that of the other.† This incision passes over the lower part of the patella and divides the lateral ligaments at once. The soft parts being then dissected up for 2 inches above the patella, so as to expose the supra-patellar pouch, deep incisions are made above and below the patella, which is then removed and the joint opened.‡

If the patella is ankylosed to the condyles, it must be removed by a blunt elevator, aided by a narrow saw, or, better, by an osteotome and mallet. No violence should be used in opening a joint partially ankylosed, or the epiphyses may easily be separated from the shaft, especially in a child.

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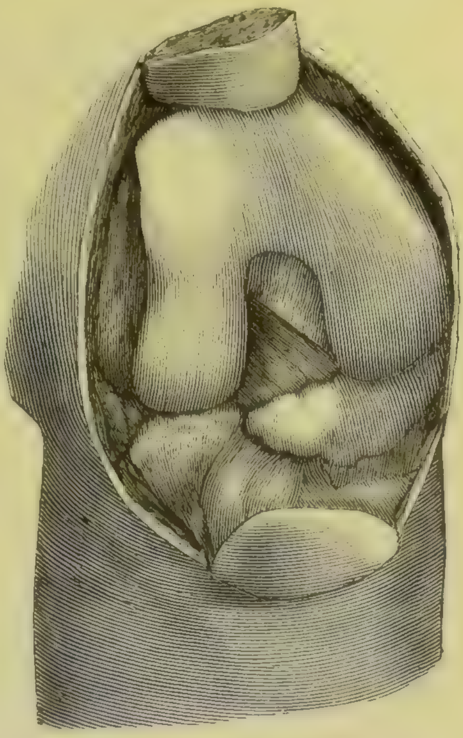
[*] This position renders it much easier for him to saw the femur and tibia.

[†] Beyond this spot the incision should not go, for fear of wounding the internal saphena vein. This would lead to troublesome œdema of the foot and leg, and, if the wound should become septic, might bring about septic phlebitis and pyæmia.

[‡] I invariably, when raising the flap of soft parts in an excision of the knee, however performed, slit them up by a vertical incision, going to the upper limit of the supra-patellar pouch, so as to expose fully all its folds and recesses. Unless this is done, pulpy material is very easily left behind, and, later on, breaking down, leads to œdema, persistent sinuses, perforation of the pouch and escape of pulpy suppuration amongst the adductors and into the vicinity of the femoral, and perforating vessels where it is impossible to eradicate it, amputation being eventually called for.

B. **Transverse, through the Patella** (Fig. 197).—This method, by preserving the patella and the insertion of the quadriceps, partly counterbalances the flexing action of the hamstrings * at the same time. Used by Volkmann many years ago, it was again brought under the notice of English surgeons by Mr. Golding Bird in a case which he brought before the Clinical Society (*Trans.*, vol. xvi. p. 82). In the seven cases in which I have employed it, it has given excellent results, though I have not sought to obtain the movable joint which Mr. Golding Bird hopes may follow on this method.

FIG. 197.



Trans-patellar excision.

The transverse incision is made here much as in the first method, only across the middle of the patella; this is sawn through or divided with a stout knife, the fragments turned up and down,† and the joint freely opened (Fig. 197). To facilitate thorough cleaning out of the supra-patellar pouch, I always slit this up, as in the first case, by a vertical incision.

C. **Semilunar Flap** (Moreau, Barker). — Here a large U-shaped flap is raised by a semilunar incision,‡ starting above one condyle, descending to the level of the tibial tubercle, crossing the leg here and running up to a corresponding point on the other side. In raising this flap, which includes all the soft parts down to the bone, either the ligamentum patellæ should be severed (suturing of this being resorted to later), or the tuberosity, attached to the ligament, is removed with a chisel, and subsequently wired down (Barker).

The joint being opened by one of the above incisions, the surgeon begins by snipping away, with blunt-pointed scissors, aided by mouse-tooth forceps, every atom of pulpy tissue around the patella and ligamentum patellæ, going as close to the bone as possible, removing completely the altered ligamentum mucosum and alaria. Then the supra-patellar pouch is in every case slit up* with a sharp bistoury to its upper limits (readily reached by a finger) so as to lay bare every crevice and remove every atom of altered tissue. The vasti fibres will now be bared, and while working downwards on the inner side the proximity of the femoral vessels must be remembered. In order to deal as systematically as possible with the diseased synovial tissue, the lateral and crucial ligaments are next examined, and every particle of diseased tissue removed, only bright, glistening, clearly healthy ligamentous tissue being left.† But as naked-eye examination in parts perhaps not absolutely bloodless may easily be fallacious, it is much better in doubtful cases to remove these completely than to run any risk whatever. The assistant who is in charge of the limb now brings the head of the tibia well into view by pulling the calf of the leg well forward with one hand while he further dislocates the bone by pushing up the leg (Fig. 198).

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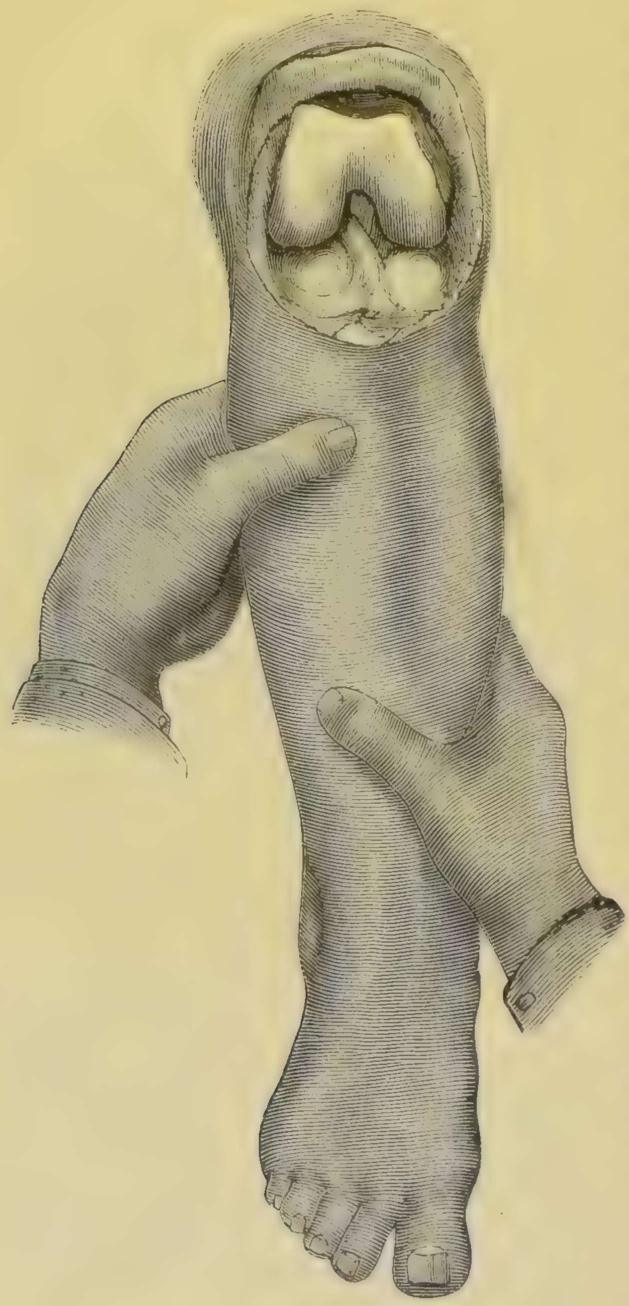
* P. 1097.

† And thus held out of the way by a sharp hook or by the aseptic finger of an assistant.

‡ The incision should begin sufficiently high up to open freely the supra-patellar pouch.

FIG. 198.



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* I look on this as one of the most cardinal points of the operation.

† Prof. Ollier (*loc. infra cit.* and *Rev. de Chir.*, 1882) drew attention to preserving the lateral ligaments, if possible, together with all healthy periosteum and capsule—*i.e.*, those tissues which will keep the bones in place and which will tend to produce ossifying material. This will not interfere, if carefully carried out, with extirpating diseased parts, while it will go far to prevent progressive flexion of the joint.

The condition of the semilunar cartilages is next examined, and if they are much invaded by pulpy tissue, or if it is intended to perform a complete excision, they must be cut away completely.

The back of the joint is next taken in hand. This region can be far more effectively dealt with after removal of the ends of the bones. If, owing to the case being an early one, with little or no caries, the surgeon decides to remain content with an erasion, he must still deal thoroughly with the posterior ligament * and deeper parts of the sides of the joint with all recesses and folds of the synovial membrane. To expose these parts thoroughly is a matter of some difficulty. The assistant should manipulate the limb as above directed at one time, at another flex the leg back towards the table, while occasionally a finger in the popliteal space will keep within reach any altered tissue that it is desired to deal with. Every pains must be taken to use the scissors systematically and thoroughly here as elsewhere, until healthy tissues are reached, and not to dread the popliteal artery too much. This should be enforced for two reasons. If any diseased tissues are left here, they will be shut in after the limb is extended and impossible to deal with, save by a fresh and probably unsuccessful operation. Again, there is always a risk, especially in a surgeon's earlier operations, of his not dealing with disease here with sufficient thoroughness from dread of injuring the popliteal artery. This vessel may be avoided by (1) not dipping the points of the scissors deeply, but using the blades as far as possible parallel with the course of the vessel; (2) by remembering that even after the posterior crucial ligament has been entirely snipped away (a matter often imperfectly done) there is still a considerable thickness of structures in front of the artery. (3) In a case where it is necessary to go very deeply to remove all doubtful patches, the Esmarch should be slackened and the pulsation felt for. But this is most rarely needed.

After all diseased tissues at the back have been thoroughly eradicated, the deeper aspects of the sides of the joint must be examined. In one case I was unable to satisfy myself that the limits of the diseased tissues were reached till the tendons of the semi-tendinosus and semi-membranosus came into view; and in another, that of the sartorius, caseating foci having spread down beneath the fascia on the inner side of the joint. If an erasion is thought sufficient, the surgeon, having gone over the synovial

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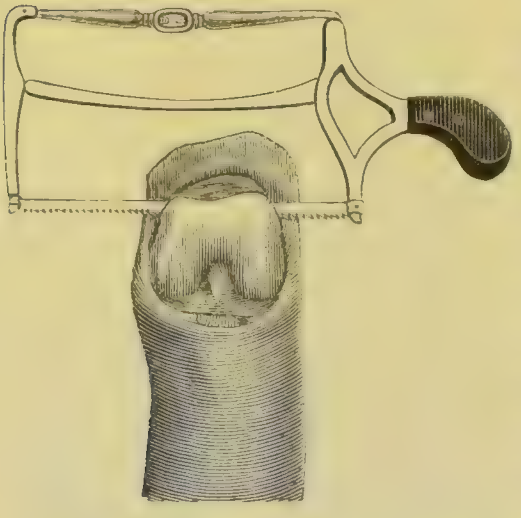
* This and the posterior parts of the semilunar fibro-cartilages are liable to be inefficiently treated.

membrane systematically and in detail, now attends to the bones. With a stout, sharp scalpel, he scrapes or pares off from the cartilaginous surfaces of femur and tibia any adherent pulpy material, removing thin shavings of the cartilage where needful. This must be carried out to the very back of the condyles and throughout the inter-condyloid notch, and around the posterior aspect of the head of the tibia.

FIG. 199.



It now remains to describe the removal of the bones in case erasion is not sufficient. Thus, excision will in future be probably called for only in cases of long standing, where caries is present, and in those with sinuses and suppuration. Where excision is evidently needed, the bones should be sawn after the supra-patellar pouch is cleared out, and before the posterior aspect of the joint is taken in hand, as this step will be much facilitated thereby.

The femur, held as steady as possible, is taken first. A groove for the saw is first so marked out with the scalpel as to remove about one-third of the condyles. In severer cases, or where the above section will clearly be insufficient, half, or even two-thirds, of the articular surface may be removed, but no section should be made further back than this, or the epiphysis will be trenched upon with serious after-results.* The section of the femur should be made slightly from above downwards, and from behind forwards, so as to be parallel with the articular cartilage and at right angles with the shaft.

The tibia is taken next, and a groove marked out with the knife about ½ inch below the articular cartilage. A Butcher's saw, set horizontally, is used from behind forwards, and on a perfectly level plane. Neither here nor in sawing the femur must the slightest wobbling of the saw be permitted.

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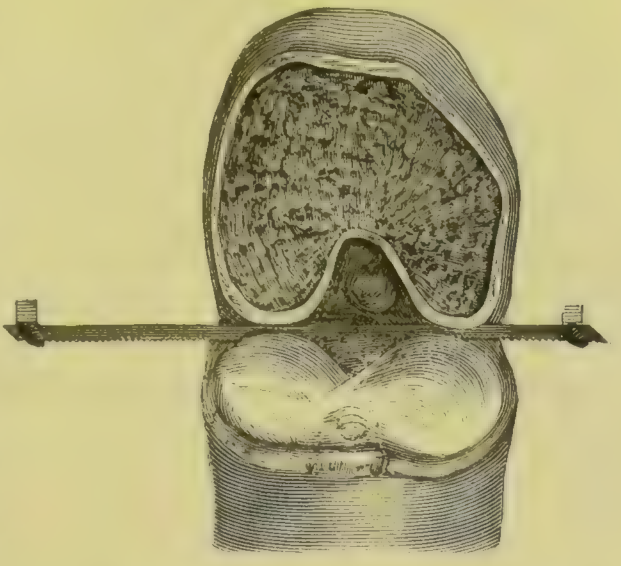
* Dr. Hoffa, of Wurzburg (*Arch. f. Klin. Chir.*, Bd. xxxii. Heft 4, 1885; *Annals of Surgery*, March 1886), brings forward cases to show that removal of both epiphyses led, at the end of ten years, to shortening, amounting to 25½ cm. (1 cm. = $\frac{4}{10}$ inch), while in another case it amounted in two years to 10 cm. Loss of the femoral epiphysis alone showed 17 cm. of shortening in six years, and 7 cm. in a year and a half. Two cases of the like duration affecting the tibial line showed respectively 15½ and 6 cm. It is, however, well known that considerable shortening may occur in cases treated expectantly. Dr. Hoffa found in one case with ankylosis at an angle that at the end of twelve years the shortening amounted to 18 cm.; in nine other such cases, ranging in duration from one to eight years, the shortening varied from 1 to 13½ cm., with angular contraction in most cases, and with very marked atrophy and trophic disturbances.

About ½ inch only of the tibia should be removed, just enough in fact to expose healthy cancellous tissue, and no more. Of the femur, no more than 1½ inch should be removed if possible.* Any soft yellow, cheesy, fatty patches, any cancellous tissue into which pulpy tissue has dipped after perforating the cartilage, should be carefully removed with a gouge. Where, however, there is much caries or the above patches are numerous, breaking down readily under the finger-nail, more than one slice of bone had better be removed.

FIG. 200.



The whole wound is now finally most carefully scrutinized, every outlying angle and recess being examined for pulpy tissue left behind.

The Esmarch's bandage is now removed, and while lint wrung out of 1 in 2000 hyd. perch. is held firmly over the sawn tibia, any bleeding points in the upper half of the wound are attended to. The safest way of arresting the bleeding is by underrunning with chromic gut and fine needles all the vessels which spirt, as practised by Mr. Howse; or Mr. Barker's plan (p. 1094) may be tried. Bleeding from the cancellous tissue will be arrested by placing the bones in contact.† If there is any tendency of the edges of the skin to fold in, these must be shortened.

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[*] Very much larger amounts may be removed if needful, especially in children and young adults, with good reparative power. If the surgeon is obliged to trench upon the epiphyses it should be with the gouge, and not with the saw, if possible. In one case of a boy, aged seven, the bones being carious, soft, and fatty, a large patch of cheesy, fatty bone presented itself in the head of the tibia after the first slice had been removed. On removing this, the gouge entered the medullary canal, which was exposed, gaping on the sawn surface. I was doubtful how far union would take place here, but three years later the boy had a most useful limb, probably from a ring of epiphysial tissue being left.

[†] The following vessels will be found to give the chief trouble after a combined erasion and excision:—One or two running down in the periosteum over the

The patella, if sawn, is now drilled and wired, or united with stout silk or chromic gut. I prefer the first, the wire being left long and removed in about a fortnight.

The question now arises whether the tibia and femur should be united by wiring or pegging.* I am of opinion that if the bones have been so sawn as to bring their faces squarely together, with sufficiently exact closeness to prevent more than a finger-nail being inserted between them, and if they are put up with the security which is given by Mr. Howse's method, the above aids are not needed.† Failure of excision is due not to deficiency of repair in the bones, but, as a rule, to persistency of pulpy, tubercular material.

Another means of arresting the hæmorrhage, and one which I have followed in my last six cases of excision and erasion, is that advised by Mr. Barker (Hunt. Lect., *supra cit.*). The Esmarch's bandage is here not removed until the dressings—a thick layer of sal-alembroth gauze, sal-alembroth or salicylic wool, or wood wool—are firmly bandaged in position. To admit of sufficient pressure being applied to check the oozing and to distribute it evenly through the dressings, a white bandage should first be applied from the foot to the upper third of the leg. If one of Mr. Howse's splints is employed, the Esmarch's bandage must be applied sufficiently high up the thigh not to interfere with the limb being placed in the splint, as this has to be done before the dressings are applied. I have found Mr. Barker's plan quite satisfactory, as long as care is taken to provide sufficient drainage: two drainage tubes should now be passed from the sides of the transverse incision to the back of the popliteal space, by counter-puncture.

The amount of drainage needed will vary. I usually, even in the least severe cases, insert one drainage-tube projecting above from the remains of the supra-patellar pouch, and below (by a counter-puncture) low down on the outer aspect of the popliteal space. Where there has been much pulpy mischief to clear out, or much oozing, the above should never be dispensed with, and

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femur, one or two in the cut periosteum surrounding the sawn margin of the tibia, and one from the azygos articular in the posterior ligament.

* The bones have been united with different forms of pegs or nails, or by wire, stout carbolized silk, or chromic gut.

† I may be speaking with insufficient knowledge, but I am under a strong impression that the advocates of these aids have not made trial of the absolute fixity ensured by a well-applied Howse's splint (*vide infra*). Mr. Morrant Baker's and Mr. Howard Marsh's methods of fixing the bones by steel or bone pins will be found in the *Brit. Med. Journ.*, 1887, vol. i. pp. 321, 389.

another tube should be similarly placed on the inner side. Twc or three sutures may be made use of in the middle of the incision, the sides being always left open. Before closing the wound, I dust a little iodoform, finely powdered, over the different surfaces, and dry these scrupulously, when the sutures are in place. Mr. Howse's splint is now applied. To those who are not familiar with the most excellent method devised by my colleague, the following brief account* may be useful. The arrangement will be found most simple, and equally efficient in admitting of antiseptic dressing and maintaining the parts in absolute rest. The splint consists of two interrupted tinned-iron troughs for the thigh and leg joined by a posterior bar. This is from 4 to 6 inches long, according to the age of the patient; it is convex from side to side to avoid cutting into the popliteal space, and can be lengthened or shortened if any alterations in the interruption are required. At the end of the splint is an adjustable foot-piece.

The limb being laid in the splint, attention must be paid to the posterior bar being in the centre of the popliteal space, the foot must be well down on the foot-piece; if the splint grips the thigh or leg too tightly or rides too loosely, it must be bent out or in with iron "crows." The dressings are now applied, preferably those of dry sal-alembroth or iodoform gauze (p. 1096). Great care must be taken to bandaging from below upwards and from within outwards, the bandage being laid on evenly and firmly so as to distribute the discharges, evenly, right through the dressings, and to prevent their coming through at one or two spots. The splint is next secured to the limb with "waxed bandages," prepared by passing them through a mixture of ordinary yellow wax and olive oil, in proportions sufficient to make the wax soft and workable. After they are applied to the leg and thigh they are painted over with a little hot wax mixture, so as to make them weld into one mass.† The limb, thus secured, is slung with cord and pulley to a Howse's cradle. This occupies the lower part of the bed; the patient lies on a half water-bed. If this splint is not at hand, a back splint, interrupted at the knee, with a foot-piece, and two side splints opposite to the knee, the back splint being secured with plaster-of-Paris, is the best substitute.

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* *Guy's Hosp. Reports*, 1877, vol. xxii. p. 503, and the accompanying plate.

† The splint is usually lined with lint wrung out of the above mixture. But the popliteal bar and any of the splint close to the wound must be metal only, uncovered, to favour asepsis. If any spaces are found to exist between the limb and the splint they may be filled in with cotton-wool, soaked in some of the hot wax mixture.

The chief points now are (1) to ensure as absolute immobility as possible; (2) to employ as infrequent* dressings as practicable; (3) to watch for every sign of relapse, and to attack it as soon as noticed.†

After-treatment.—Morphia or laudanum should be used freely at first, if needful. If the temperature keep down, the dressings should be left undisturbed for two weeks, when an anæsthetic should be given to remove the wire if the excision has been a trans-patellar one, take out any drainage-tubes, and also to make sure that there are no persistent sinuses pointing to residual pulpy material. These, if found, must be slit up with a sharp-pointed curved bistoury, and scraped out with a sharp spoon. While this may be repeated every two weeks, on five or six occasions successfully, the more deliberately the surgeon endeavours to extirpate the disease both in the soft parts and in the bones, the more he treats it as if malignant at first, the less often will he have to interfere later on.

In about three months, Mr. Howse's splint may be left off and a leather splint fitted on, carrying a metal bar to resist the tendency to flexion. Some such fixed apparatus should be worn, in children, for three or more years.*

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* Infrequency of dressings has been strongly insisted on by Prof. Ollier (*Rev. de Chir.*, August 1887; *Annals of Surgery*, November 1887, p. 424). This most important economy—of pain to the patient, and time to the surgeon—is only to be secured by—(1) Removing every atom of the disease that can be got at. (2) Providing drainage. The more thoroughly the disease is extirpated, the less need is there to drain; but however completely the disease is removed, many sutures should not be employed, especially at the ends of the wound. (3) Using dry dressings. Of these sal-alembroth or iodoform gauze (either being used with iodoform) is the best, the first being the one I prefer, from its efficiency, its softness, its cheapness, and the fact that the parts not discoloured by the discharges can be used again. Excellent pioneering work as carbolic oil gauze did, it had the great disadvantage of being moist. Unless most carefully wrung out—a thing difficult to secure in a surgical ward, where a large number of dressings have to be provided together—within twenty-four hours, it was difficult to say how much of the discharge was oily and how much serous; the surgeon knowing that he would not have a chance of seeing the case—perhaps an important one—for another twenty-four hours, had the dressings changed, very often, I think, needlessly. Of course, in many cases this infrequency of dressings is impossible to secure—*e.g.*, where all the disease cannot have been removed at the first operation, and the temperature keeps up, probably accompanied with pain; (2) where sinuses have been present, and the joint is probably septic. In such cases, if needful, the dressings must be changed daily, to enable the surgeon at once to decide as to the need of again attacking any relapse (*vide supra*). Infrequency of dressings will not interfere with the use of drainage-tubes.

† It is especially, I think, from neglect of this last detail, that the fact arises that almost as many cases are lost from mistakes in the after-treatment as from want of skill in the operation.

Causes of Failure and Death after Excision of the Knee.—1. Inveterate persistence of pulpy material leading to (α) giving way of the supra-patellar pouch, and the results mentioned at p. 1088; (β) to formation of caseating foci, especially at the back of the joint (p. 1091), and only to be removed by re-excision or amputation. 2. An unhealthy condition of the bone ends, with caries and chronic osteo-myelitis. 3. Deficient reparative power, leading to bed-sores, emaciation, irritative fever, hectic. 4. Co-existence or subsequent development of such visceral diseases as phthisis, &c. 5. Surgical scarlet fever. 6. Septic Conditions.—For these the surgeon will, nowadays, be, as a rule, entirely to blame. 7. Tetanus (p. 1085). 8. Secondary Hæmorrhage.—Another very rare condition. 9. Fat Embolism.—This is a still rarer condition, but one which, on account of the interest it excited some years ago, and because it has once, at least, proved fatal, deserves mention here. The case was that of a child, aged twelve, submitted to excision for pulpy disease by Vogt, of Griefswald (*Cent. f. Chir.*, 1883, p. 24). The bones were so fatty as to cut with a knife. Though but little chloroform had been given, and the loss of blood had been slight, the patient died twenty-four hours later with shallow respirations, feeble pulse, and low temperature. Fat embolism of the lungs, extensively diffused, was found post mortem. Vogt considered that this case predisposed to fat embolism. Thus cut vessels were exposed on the sawn surfaces with plenty of free oily matter close by, and unable to escape, owing to the bone-ends being in close contact (two wire sutures were used). A similar case, after hip resection, by Prof. Lücke, is mentioned. Prof. Vogt thought that he would amputate in another case if, after excision of the knee, the limb could not be straightened without close apposition of the sawn fatty bone-ends. 9. Shock.—This, though rare, must be remembered. Thirteen years ago I lost a case from this cause. The patient was a delicate boy, aged seven, with a large pulpy knee. As there was no suppuration, no sinuses, nor evidence of much mischief in the bones, I, unwisely as it proved, tried to save the limb. The child sank a few hours afterwards. Volkmann (*Cent. f. Chir.*, Bd. xii. Heft 9, Feb. 28, 1885; *Ann. of Surg.*, May 1885, p. 486) draws attention to the need of taking care in children that too much blood is not lost, and that deep narcosis is not too prolonged.

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* In early life callus-like material is thrown out quickly, and often somewhat irregularly, between the bones, but it is extremely slow in really ossifying. As the quadriceps extensor wastes much more quickly than the hamstrings, even when the patella is retained, the latter muscles keep up their action on the tibia for months, and even for years, until the union is firm. Tenotomy has been advised, and even resection of all the hamstring tendons (Dr. Phelps, *New York Med. Record*, July 21, 1886; *Annals of Surgery*, October 1886, p. 364). I think, however, that retaining the bones immobile and in good position, securing early healing of the wound, wearing a stiff apparatus, and, wherever practicable, using the trans-patellar method, will best ensure a limb soundly ankylosed in good position. A knee bent later on can be easily straightened.

ERASION [*] OF THE KNEE-JOINT.

Definition.—By this operation, which we owe to G. A. Wright,[†] of Manchester, is meant a systematic removal of the synovial membrane, which is, here, so often pulpy. If the ligaments are diseased, they are also removed; but if the bones and cartilage be involved, it must be only to a slight degree, so that all the disease can be got away by paring with a knife, or scraping out with a sharp spoon. Where sections of the bone have to be made, the operation becomes an excision as well as an erasion.

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[*] *Lancet*, 1881, vol. ii. p. 992; *Med. Chron.*, July 1885. See also a paper by Mr. Shield (*Ann. of Surg.*, Feb. 1888), and one by Mr. Owen (*Med.-Chir. Trans.*, vol. lxxii. p. 56). The following are Mr. Wright's conclusions: "In those that have done well the common factors appear to be: (1) absence or very small amount of suppuration; (2) superficial or, at least, not widespread bone disease; (3) absence of general tuberculosis. In short, fairly early disease in a not hopelessly tuberculous child. This pretty well corresponds to the cases generally considered suitable for excision. I have not yet tried the operation in adults. It is clear that extensive disease of bone and much suppuration will not allow good results to be obtained by erasion; neither, as a general rule, will they by excision, though I am quite sure that the knee may be successfully excised in cases where erasion is out of the question, as shown by excision succeeding where erasion has failed. Although in one case a freely movable joint resulted, I do not advise the attempt to obtain mobility by early passive movement, except in a few instances where the wound has healed at once, and there is no obstacle in the way such as dense and lowly vitalized cicatricial tissue. Erasion, if it fails, leaves the limb little, if at all, in worse condition for excision afterwards. In those cases where amputation became necessary, either the local or constitutional condition forbade hope of successful excision. Where it succeeds, erasion leaves as sound a limb as excision, without shortening. In some cases there may be mobility, though I think in most it will be found that there is not enough mobility to be useful; here the limb is very liable to become flexed after healing of the wound, but the same is true of excision in children. I think, then, that in suitable cases erasion is, in disease of the knee, better surgery than excision, but its application is strictly limited. In all cases I have employed strictly Listerian antiseptics."

[†] Arthrectomy was a term introduced by Volkmann (*Cent. f. Chir.*, 1888). It is less accurate, and etymologically comes too near to excision.

Value of Erasion as compared with Excision; Suitable and Unsuitable Cases.—Where a knee-joint the site of pulpy trouble resists, in hospital patients, non-operative treatment continued for three or four months; where there is no evidence of caseation in the joint (very difficult to tell, but indicated by chronic obstinacy of the disease, by spots where the feel is distinctly doughy or becoming bluish in tint)—in other words, where the disease is early, but owing to the patient's surroundings will go on from bad to worse, erasion is preferable to excision. Its *advantages* are, (1) There is no removal of bone-slices, and, still less, any interference with the epiphyses. Thus there is no shortening and no arrest of growth. This latter advantage will be at once recognized, when it is remembered that (p. 1042) the increase in length of the femur takes place chiefly at the junction of its shaft with the lower epiphysis, and in the case of the tibia at its upper epiphysis. In one of my cases, a girl of eleven, there was not only no shortening, but repeated careful measurements showed ½ an inch increase of length, perhaps due to the increase of vascularity after the operation, about the above-mentioned epiphyses. (2) With regard to the retention of mobility, the frequency with which this has been obtained and its advantage have been, in my opinion, much exaggerated. I have no doubt whatever that a larger number of carefully published cases will show that where movement is sought for the risk is run of a certain degree of permanent flexion. I should strongly dissuade from any attempt to secure mobility in the case of the knee and ankle. (3) The ligaments are less interfered with, and thus the ties of the joint being preserved, firm union is more speedy. (4) If performed early, erasion, like excision, cuts short the disease, and thus gives a considerable saving of time in children, at an age when every month is of great importance. (5) It is better suited to young children. Thus, as it does not arrest development, it may be used very early. Wright has operated "with perfect success in a child under two years of age."

The *disadvantage* of erasion—I am speaking only from an experience of eight cases—is, I think, chiefly this, that if the operation fail, excision is rendered much more difficult. I cannot here at all agree with the statement of my old friend, the chief authority on this subject, that erasion, if it fail, leaves the limb little, if at all, in worse condition for excision afterwards. This is true of the limb, but not of the joint. In one case of my eight erasions which required excision, I found that the previous operation had entirely obliterated the usual landmarks, and that great difficulty was experienced and much care needed in dealing with such parts as the remains of the posterior ligament.

The *cases suitable for erasion* are those where the disease is limited, or almost limited, to the synovial membrane, with little, if any, caseation; where the cartilage and bones are almost intact, where there are no abscesses or sinuses, where there is no evidence of other tubercular disease, and where the power of repair is satisfactory.

Operation.—The preliminaries are the same as for excision (p. 1087). In order to expose the supra-patellar pouch thoroughly, either a trans-patellar incision or a semilunar one with its convexity *upwards* (the flap being thrown down) should be employed. I prefer the former (p. 1089); but to ensure thorough exposure of the supra-patellar region, a very dangerous area on account of its numerous nooks and crannies which give lurking-places to pulpy mischief, I always slit this pouch right up to its very top with a sharp-pointed bistoury, thus dividing the upper flap into two. G. A. Wright ensures the same end by making "longitudinal incisions through the tissues on each side of both halves of the patella, upwards as far as the upper limit of the synovial pouch, and downwards nearly to the tubercle of the patella." The flaps being then one by one thoroughly everted with a sharp hook, taking the upper half of the joint first, I seize the tip of one of the flaps with minute tooth-forceps, and then with blunt-pointed scissors curved on the flap dissect the diseased synovial membrane off the under surface of the split quadriceps expansion in a continuous strip till the uppermost limit of the supra-patellar pouch is reached. The reflection of the synovial membrane over the front of the femur is then dealt with in the same way, leaving the periosteum on this quite clean. The joint being then well bent, and the tibia being brought forward as directed (p. 1090, Fig. 198), the crucial ligaments, the semilunar cartilages, the inter-condyloid notch, and the synovial reflections behind the crucial ligaments are carefully inspected. To do this thoroughly it is absolutely needful to divide the lateral ligaments freely. With regard to the other structures, some retain the semilunar cartilages if healthy, others remove them in any case. For my part, as it is so essential to remove *all* the synovial membrane, and as this is impossible unless the semilunar cartilages go, I always remove them. With regard to the crucial ligaments, the anterior nearly always requires removal; the posterior, if clearly healthy and glistening, may remain. The inter-condyloid notch, and the reflection behind the crucial ligaments, is then taken in hand, very wide flexion of the joint, and a finger of an assistant in the popliteal space, here facilitating this, the most difficult and important part of the operation. When much disease is present here in the synovial membrane, both crucial ligaments must be unhesitatingly divided, and, if needful, the overhanging posterior part of the condyles must be cut away. In dealing with the synovial membrane in the inter-condyloid notch, the surgeon must remember that he will never have a similar chance of dealing with the disease here, and that, if any is left behind, excision, and perhaps amputation, will be called for. The synovial membrane around the lower half of the patella is then removed, and finally the ends of the bones are examined. Any pits and foci are gouged out, and more extensive ulceration shaved off with a strong sharp knife. Drainage is then provided by making counter-punctures with a Lister's sinus-forceps in the popliteal space, on each side of the limb.* The dressings are applied with the same precautions given at p. 1094, and when the limb is placed in the splint the Esmarch's bandage is removed. Throughout the operation irrigation with lot. hyd. perch., 1 in 2000, should be diligently employed.

The after-treatment is the same as after excision (p. 1096); as there is the same tendency for a long while for the limb to become flexed, there is the same urgent need for a rigid apparatus for several years.

Causes of Failure after Erasion.—These are chiefly: (1) Some of the disease is left behind. This is known by a persistent sinus, and the liability of the limb to become puffy, hot, and tender. (2) Inability of the patient to repair the wound which is left. (3) Failure of the surgeon to maintain asepsis.

WIRING UNUNITED FRACTURES OF PATELLA.

This operation, brought before the profession by Sir J. Lister in 1883, seems lately to have dropped out of notice. This is perhaps due to two facts: (*a*) In the majority of cases a quite sufficiently good result is obtained by non-operative means.†

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* Some advise a drainage-tube to be passed by counter-puncture through the middle of the popliteal space. I object to this plan, as the tube is likely to become blocked when the bones are brought into position, and, if it is necessary to retain it for a while, it may easily, by its pressure, produce caries.

† Mr. Ogier Ward (*Lancet*, November 1, 1884), in some interesting remarks on three cases—of which one was treated without, and the other two by, wiring—shows that in the first the total time lost before resuming work was twenty-seven weeks, and in the two wired, thirteen and eight weeks respectively; that the first case could not kneel before nine months, while the other two could do so six and five

(*b*) In spite of the vastly increased familiarity with antiseptic details, and their simplification, much of the old dread of opening the knee-joint still survives. The question was, however, sufficiently thrashed out to make it clear that the operation is justifiable under certain conditions. The indications may be stated somewhat thus:—

1. In Sir J. Lister's words (*loc. supra cit.*), "no man is justified in performing such an operation unless he can say with a clear conscience that he considers himself morally certain of avoiding the entrance of any septic mischief into the wound."

2. Certain Cases of Old Fracture of the Patella.—This important matter must be taken somewhat in detail. The chief points here justifying resort to wiring are—(*a*) Failure of previous treatment, especially in hospital patients. (*b*) A useless limb, especially in a man whose occupation entails much walking or standing, where the gait is helpless and requires much attention, or where many falls have followed involving serious risk of fracture on the opposite side. (*c*) Where both patellæ are fractured. (*d*) Where the patient is young and has many years of active life before him. (*e*) Where, if not young, the patient is sufficiently healthy. (*f*) Where enough is known of the patient's habits to ensure his being amenable.

3. Recent Fractures.—These must be considered separately, according as they are—(*a*) simple; or (*b*) compound. In the former case the general opinion of the profession has appeared to be against operation, owing to the good result which usually follows on non-operative measures. Prof. Lister's [*] five cases of wiring in recent fractures prove how safe this method is in skilled hands. (*b*) In compound fractures the matter seems to me to be different. Here a wound already exists, and if the patient's condition is good no harm can be done by wiring, with antiseptic precautions, any fragments which happen to be widely separated. Furthermore, such a step may be easily combined with the needful examination and irrigation of the joint with dilute solution of mercury perchloride or carbolic acid, and the insufflation of iodoform.[†]

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weeks after the operation. It will be seen that the loss of time was reduced by more than one-half.

[*] Sir Joseph goes so far as to consider (*Lancet*, November 3, 1883) that "the ununited case is in every respect worse as a subject of operation than the recent." This is chiefly owing to the wasting of the fragments and their greater separation. Again, in recent cases, there is no need to pare the fragments, for after sponging away of clots the surfaces are ready for coaptation.

[†] Dr. G. R. Fowler, of New York (*Annals of Surgery*, September 1885, p. 248), calls attention to the great importance of making these cases aseptic at the

Operation.—The parts being thoroughly cleansed, an incision is made, with the strictest antiseptic precautions, including irrigation with hyd. perch., 1 in 2000, about 3½ inches long, either vertically or transversely. The former is adopted by Sir J. Lister. The latter is the more convenient, and admits more readily of getting at the lateral aspects of the joint, if the aponeurosis above requires division at these points.* It is said to have the disadvantage of being more likely to give way and expose the joint if a refracture should take place later. I used it in the two cases mentioned below, and think it well to make it rather above or below the interval between the fragments, so that this and the wound shall not lie opposite to each other.† The fragments when exposed‡ are generally found embedded in fibrous tissue, thickened synovial membrane, and old decolorized coagulum. This must be snipped or cut away, and any spirting vessels in the thickened synovial membrane must be secured. A very thin section from each fragment is then removed with a narrow-bladed saw, this needing much caution in the case of the lower one, which is the smaller of the two. If the fragments can now be pressed into close apposition, nothing remains save to wire them, but the case is by no means so simple where the bones are widely apart. Thus, in one of my cases, after paring the fragments, these were quite 2½ inches from each other, and after most forcible traction, the upper could only be made to descend ¾ inch. Malgaigne's hooks were now applied and tightly screwed up, but with no result on the desired approximation. The lateral expansions of the quadriceps were next still more fully divided (cut muscular fibres being seen on the inner side), but the fragments were almost as far apart as ever. As the only alternative to excising the joint (in order to substitute a firm support for the flail-like limb), I now divided partially the rectus tendon, but it was not till the upper fragment was only held by a narrow stout band at its upper and inner parts that it could be brought in apposition with the lower one. The result was excellent.

In these difficult cases it must be remembered that it is not

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first. In his case the bone was split into three fragments. The two lower ones were first wired together, and their upper margins were next sutured to the upper fragment by two wire sutures, one for each lower fragment.

* It would also be probably more convenient in a compound fracture.

† An Esmarch's bandage is not needed, and would have the objections of causing oozing afterwards into the joint cavity, and also of preventing that bringing down of the extensors of the thigh which may be required in cases of wide separation.

‡ In one case, the skin being dimpled, puckered down, and adherent between the fragments, I had to cut away a piece about ¾ inch in diameter.

absolutely necessary to get the fragments into exact apposition. If, after wiring, they come within ¼ inch of each other, the limb will be a most useful one, though of course exact apposition is to be desired.* When, in spite of all the above, approximation of the fragments is still impossible—though it is difficult to imagine such a contingency—the knee should be excised either now, or on another occasion, so as to give a firm support.

The fragments being sufficiently approximated, they are now drilled. This may be easily effected by an ordinary clean bradawl. The bones should be drilled obliquely, the instrument entering each fragment a full ½ inch from the fracture on the upper surface, and emerging above the cartilaginous surface below.† Where the lower fragment is too small to hold a wire,‡ this may be passed through the ligamentum patellæ, as has been done by Sir J. Lister (*loc. supra cit.*) and Mr. Teale (*Brit. Med. Journ.*, June 9, 1883). One wire would appear to be sufficient: though this unites the centre of the fragments exactly, a very slight interval remains at the edges, but does not interfere with an excellent result.

When the wire is twisted, two half twists, or one complete one, will be sufficient, and it should be noted at the time in which direction the twist is made, in case the wire is removed. This raises the question as to **the best way of dealing with the wire**, whether to cut it short and embed the ends by gently hammering them into the fibrous tissue over the upper fragment, or to leave the wire long enough to admit of its being removed later. I have alluded to this question at p. 69. Sir J. Lister advocates the former course. I shall not, I trust, be thought wanting in proper respect if I suggest that in the knee, at least in women who have much kneeling, removal of the wire will be more satisfactory. Thus, in one of my cases, in which I had hammered down the wire, the woman returned nearly a year later to have the wire removed. She had not been able to kneel, the suture could be felt, and at one spot the skin was ulcerating over it. I ought to state that the patient was a very thin one, and that I had made three or four half twists instead of two (p. 69).*

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* In a case of Mr. Wheelhouse's (*Brit. Med. Journ.*, June 9, 1883) the fragments, originally 1½ inch apart, could only be brought within ½ inch of each other; an excellent limb resulted.

† While it is well to take this last precaution, it probably does not matter much (supposing, of course, that strict antiseptic precautions are taken) if the wire is passed within the joint. Sir J. Lister gives the following aid to making the two drill-holes exactly correspond :—"Supposing that on one side the instrument should have come too far down, it may be into the cartilage ; we do not regard that at first, but pass the wire through the two drill-holes, and then on that side on which the hole has come too far down, by means of the bradawl we simply chip away a little of the material that is above the wire, until the wire comes to be in a position exactly opposite to the hole on the other side." If, in another case, there is difficulty in making the drill emerge upon the fractured surface, Sir Joseph would advise to withdraw the drill and substitute the blunt end of a needle, and then with a gouge or bradawl to excavate an opening upon the fractured surface, opposite to the other drill-hole, until the needle is exposed ; the wire can then be easily passed.

‡ The most difficult fragment should be taken first. The wire is liable to hitch at two points—one in hitting off the drilled orifice in the second fragment; the other, as it comes up through the fibrous tissue covering this fragment.

Before the wire is twisted or hammered down, if this course is decided upon, the surgeon must decide as to **drainage** of the joint. When the operation has been difficult, involving much separation of adhesions, and interference with the parts, drainage should be employed through the wound to the most dependent part of the joint at the outer side (Lister), thrusting the instrument here through the joint and soft parts, cutting upon it and drawing a drain through. The wound is then united and dressed. As soon as the deeper part of the wound is healed, every pains must be taken, by massage, &c., to improve the atrophy of the quadriceps. Healing should be complete in three weeks. If it be decided to remove the wire, this may be done six or eight weeks after the operation, by making a small incision through the scar. The number of half-twists and the direction in which they have been made must be recollected at this time. The wire is first untwisted and straightened, one end is next cut off short, and the other grasped in dressing-forceps, and wound round the tips of these. It is then extracted without jerking.

The **question of passive movement** now arises. Usually, about six or eight weeks after the operation, the patient may get up and begin to use the limb (with the aid of two sticks at first), flexion and extension being diligently practised. Unless the joint is very stiff, massage, friction, and gentle persevering movement, aided by time and patience, will be sufficient. If an anæsthetic is given, movements must be made cautiously, as the patella has been refractured on this occasion more than once.*

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* Dr. Macewen (*loc. infra cit.*) mentions a case which came under observation three months after suture of the patella, with acute suppurative arthritis of the joint and ulceration of the cartilage. A probe passed through a sinus detected the wire surrounded by carious bone. The twist was still intact, but the loop was loose, the bone having become inflamed, softened, and ulcerated. Excision of the joint was required. This shows that occasionally the wire may excite irritation and thus lead to serious results. Mr. Turner (*Lancet*, 1887, vol. i. p. 572) records a case in which Mr. M. Robson, of Leeds, had wired an ununited fracture of the patella, three gold wires being employed. The patient, an epileptic, probably injured the knee repeatedly, the wires worked out, and the knee-joint became acutely inflamed, requiring free incisions and drainage.

Difficulties in Wiring the Patella.

1. Atrophied surfaces of the fragments, making it difficult to refresh them satisfactorily. 2. A very small lower fragment. 3. Fragments embedded in very firm fibrous tissue, fascial, periosteal, and synovial, or old coagulum. This condition will prevent satisfactory apposition unless the intervening tissue be all removed. In a very interesting case recorded by Mr. O. Ward (*Lancet*, Nov. 1, 1884) it was found, on exploring the fragments, that the capsular tissues torn off the lower fragment remained attached above, and hung like a flap between the fractured surfaces, effectually preventing their apposition. It is suggested that some such complication may, in many cases which have been treated in the usual way, cause the fragments to fall apart as time goes on. This is supported by Dr. Macewen (*Lancet*, Nov. 17, 1883; *Ann. of Surg.*, March 1887, p. 178), who has collected thirteen cases of transverse fracture of the patella, in which portions of soft tissue intervened between the fragments in such a manner as to render osseous union an impossibility. 4. A contracted, rigid quadriceps. 5. In-dipping skin, p. 1103. 6. Multiple fragments.—This may cause much difficulty, especially if it is the lower and usually smaller fragment which is comminuted. If the lowest fragment is large enough to bear wiring, a smaller one may be removed; or the wire may be passed through the ligamentum patellæ. If a case seemed to require it I should not hesitate to wire smaller fragments with finer wire, and to pass one stout one from the highest to the lowest fragment (or ligamentum patellæ), this wire lying in the joint, and passing under and over one of the smaller ones. To give a firm support excision could be resorted to as a last resort, either at the time or later.†

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* In one of Sir J. Lister's cases (*loc. supra cit.*), passive movement being employed with "considerable force" four weeks after the wiring, the rigid quadriceps not yielding, the wire gave way, and the cicatrix (a long longitudinal one), which had healed save where the wire projected, opened. The joint was at once washed out antiseptically, and, six days later, some coagula were removed and the old wire retwisted. An excellent limb was the result.

† Mr. Mayo Robson brought the following method of securing bony union of the patella without opening the knee-joint before the Clinical Society (*Trans.*, vol. xxii. p. 286; *Brit. Med. Journ.*, 1889, vol. i. p. 1229). The parts being carefully purified, the joint aspirated, the skin over the upper fragment was drawn up so as to avoid traction on the skin, and a pin was pushed from without inwards, through the quadriceps tendon immediately above the upper fragment, and made to project at a corresponding point on the opposite side of the knee. Another pin was in like manner pushed through the upper end of the ligamentum

Causes of Failure.—These are mainly :—1. Inability to bring the Fragments together.—Mr. Turner (*Clin. Soc. Trans.*, vol. xvii. p. 41) mentions a case in which the operation was abandoned, as it was found impossible to get the fragments together after wiring them. The patient was "no better and no worse" eventually. 2. Septic conditions. 3. Necrosis of a Fragment.—This is a complication rather than a cause of failure. It is especially likely to occur after severe compound fractures, in which the periosteum was much injured at the time of the accident. This happened with the upper fragment in Dr. G. R. Fowler's case already quoted. About three months after the wiring, this fragment, about the size of a walnut, was removed. It was now found that "the joint was perfectly closed by a thick fibrous capsule underlying the necrosed portion, connected to the upper margins of the now firmly united two lower fragments, and forming a strong bond of union between the quadriceps above and what remained of the patella below." The resulting limb was useful, with considerable movement at the knee-joint.

REMOVAL OF LOOSE BODIES * FROM THE KNEE-JOINT.

This is another instance of an operation rendered safe and simple by the antiseptic treatment of Sir J. Lister. Removal by **direct incision** will therefore be alone described here.

Operation.—The parts having been kept at rest for some days before and scrupulously cleansed, the foreign body is found,† if

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patellæ, just below the lower fragment. Gentle traction on the pins quite easily brought the fragments into contact, and a figure-of-eight suture of aseptic silk retained them in position. An antiseptic dressing was applied and not removed for three weeks, when the pins were removed. Bony union was secured.

* The following classification may be useful to a surgeon about to operate for one of these bodies :—(1) A thickened or indurated synovial fringe which has become pedunculated and perhaps detached; (2) a fibro-enchondroma originating in those cartilage cells which are naturally found in the synovial fringes; (3) a portion of articular cartilage detached by injury (four years ago I removed one of these loose bodies from the knee-joint of a railway porter who came to me for synovitis, with the history that the attacks dated from the time when a cask which he was moving had slipped and struck the inner side of his right knee-joint—*Lancet*, 1889, vol. ii. p. 363); (4) a bit of cartilage may, after injury, gradually become detached by a process of quiet necrosis (Paget); (5) blood effused into a synovial fringe; (6) a mass of fibrine; (7) a detached osteophyte; (8) Mr. H. Marsh (*Dis. of Joints*, p. 182) mentions a case of Mr. Shaw's, in which a loose body on removal was found to contain the point of a needle.

† The patient is often clever at this. Mr. H. Marsh (*loc. supra cit.*) suggests that it may save disappointment if fixing the body has been practised beforehand

possible, and retained in a superficial part of the capsule. If it be very movable, it should be harpooned with a sharp needle at the beginning of the operation. The joint is then deliberately and sufficiently opened. In the traumatic case I have mentioned, the body could not be felt at the time of the operation; on cutting freely into the joint I came down on a tiny pedunculated body attached to the deformed internal condyle; as this was evidently too small to be the offending body, I had, after removing it, to make a prolonged search with the finger before the loose cartilage was found at the extreme upper end of the supra-patellar pouch. In any such case where the body can be felt, but not brought down, a second incision should be made over it. Any bleeding is now finally arrested, and the wound closed by sutures which carefully take up the capsule. If the operation has been a simple one, no drainage will be required, effusion being prevented by aseptic precautions and firm, even bandaging. Where the search has been prolonged, the parts much interfered with, or many bodies removed, a horsehair drain or a small tube must be passed through the wound, and a counter-puncture at the most dependent part of the joint.

Iodoform having been dusted on, dry antiseptic dressings are applied, and the limb put up on a back splint.

INTERNAL DERANGEMENTS OF THE KNEE.—SLIPPED FIBRO-CARTILAGE.*

These affections are so crippling and vexatious that I shall allude to them here, though operative interference will be very rarely required if the case is treated by the proper apparatus (*vide infra*). The key-note to the satisfactory recognition of these injuries and their well-doing, is a recognition of the fact that one of the semilunar cartilages, usually the internal, may after a hurt or wrench of the joint be partially torn away from its marginal attachments, usually the anterior ones (Annandale). In some cases the cartilage is split instead of displaced; in others it under-

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by the assistant to whom this office is to be entrusted. In those rare cases where the body cannot be found, no surgeon familiar with antiseptic details would hesitate to freely cut into the joint if the history and the crippling of the patient justified this. In other cases, as occasionally happens in lithotomy, the body is known to be present, but cannot be felt when the patient is on the table.

* Reference should be made on this subject to the following writings:—Hey *Pract. Observ. in Surg.*, 1803; Howard Marsh, *Dis. of the Joints*, p. 190; Annandale, *Brit. Med. Journ.*, 1887, vol. i. p. 319; H. W. Allingham, *ibid.* 1888, vol. i p. 1110, and *Treatment of Internal Derangements of Knee-Joint by Operation.*

goes gradual enlargement in consequence of repeated injury and synovial irritation.* With regard to treatment, it should be distinctly understood that, after reduction, rest, counter-irritation, &c., the application of ordinary splints or knee-caps is of the very slightest use; there is one instrument, and, as far as I know, one only, which will meet these cases, and do away in the great majority of cases with any need of operation, and that is the "knee-clamps" made by Spratt, of New Bond Street, and figured by Mr. H. Marsh in his excellent account of this affection (*Dis. of the Joints*, pp. 212, 213). Having ordered these clamps several times, I can testify most strongly to their value.

Operation.—Where the above clamps fail, or where an actual growth is present, as in Prof. Annandale's case; where the life is spoilt by the affection, and other conditions are satisfactory, opening the joint and suture or removal of the cartilage is justifiable. The skin being carefully cleansed, and the strictest antiseptic precautions being made use of, an incision—a transverse gives the most room—is made over the fibro-cartilage, from the ligamentum patellæ inwards or outwards for about 3 inches. All bleeding being carefully arrested, the synovial membrane is incised, and hæmorrhage again stopped. The condition of the cartilage is then investigated, and if displaced it is drawn into position with a blunt hook, and sutured with chromic catgut to the periosteum and fascia over the edge of the head of the tibia. If the cartilage cannot be thus brought into position, it should be removed, and the same should be done if a portion is found split off but still attached. Any growth that is present, as in Prof. Annandale's cases, whether fibro-fatty of the synovial membrane, or an osteo-arthritic outgrowth from the bone, should be removed by scissors or chisel. A few strands of horsehair are then inserted, and the synovial membrane carefully sutured with buried sutures of catgut. The skin incision is then closed with salmon-gut sutures. In about three weeks careful movements of the joint should be begun. The chief trouble in the after-treatment is obstinate stiffness.

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* In very rare cases, with the history and symptoms of displaced fibro-cartilage, the menisci are found *in situ*, and the only abnormality and cause of interference with the movements of the joint is a small mass of fibro-fatty tissue lying over the fibro-cartilage at the site of pain (Annandale, *Brit. Med. Journ.*, 1887, vol. i. p. 320).

CHAPTER IV.

OPERATIONS ON THE POPLITEAL SPACE.

LIGATURE OF THE POPLITEAL ARTERY.

Indications.—Extremely few. 1. Stab or punctured wound.—Here the surgeon would only resort to ligature, (1) if pressure was unavailing; (2) if the patient insisted on running the risk of gangrene; (3) it would be well, if possible, to get leave for immediate amputation if the vein was found injured also. 2. In some cases of ruptured popliteal artery it will be right to explore and see if any other complication exists beyond the rupture of the artery.* If there is no injury to the vein, nerves, or the joint (a very unlikely contingency), the rupture may be treated by double ligatures as elsewhere. The surgeon must afterwards be prepared to amputate through the lower third of the thigh on the first sign of gangrene appearing. The operation of ligature of the popliteal artery is extremely difficult here, owing to the depth of the vessel, the strong fascia, the amount of coagulated blood, and the infiltrated, obscured condition of the parts. Primary amputation will, as a rule, be required in cases of ruptured popliteal artery, especially where skilled assistance and facilities for antiseptic treatment are not at hand. A free incision will enable the surgeon to investigate the amount of injury, and at the same time will relieve tension if an attempt is made to relieve the limb. This incision may form part of the amputation (p. 1079). 3. The artery has been wounded in the course of an osteotomy of the lower end of the femur. In such a case the vessel should be reached by the incision given at Fig. 202. 4. "Possibly in a small traumatic aneurism" (Sir W. Mac Cormac, *Ligature of Arteries*, p. 109). If any surgeon is inclined to perform the old operation for a ruptured popliteal aneurism, he should first consult a clinical lecture on a case of this kind by Mr. Holmes. The difficulties which may be expected are graphically described, and the wisdom of amputation shown.

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* Poland, *Guy's Hosp. Reports*, third series, vol. vi. p. 294.

EXTENT.—From the adductor opening to the lower border of the popliteus.

GUIDES.—*Behind:* A line drawn from just inside the inner hamstrings above to the centre of the lower part of the popliteal space. *In Front:* The tendon of the adductor magnus.

RELATIONS (in the popliteal space):—

IN FRONT.

Skin; fasciæ; small sciatic nerve above; short saphena vein and external saphena nerve below; fat; glands.
Semi-membranosus, above; gastrocnemius, plantaris, soleus, below.
Internal popliteal nerve; popliteal vein, outside above, inside below, exactly over the artery in the centre of the space.
Branch of obturator above.

OUTSIDE.	INSIDE.
Biceps, above; gastrocnemius, and plantaris, below.	Semi-membranosus, above, gastrocnemius, below.

Popliteal artery.

BEHIND.

Femur.
Posterior ligament.
Popliteus.

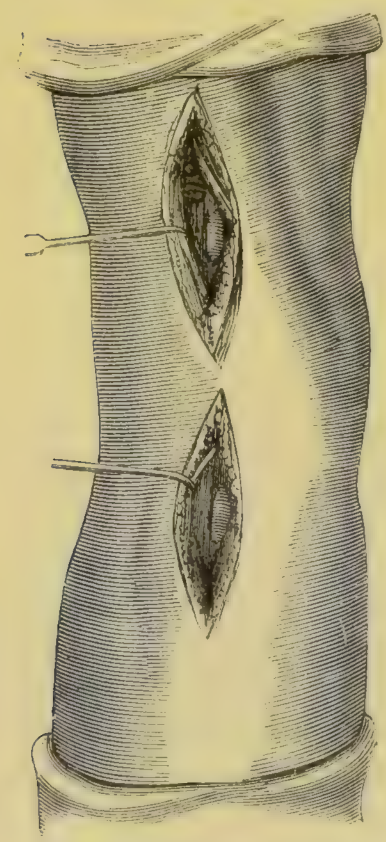
Collateral Circulation.

ABOVE.		BELOW.
Anastomotica magna, superior articular, descending branch of external circumflex.	with	Inferior articular, and recurrent from anterior tibial.

Operations (Figs. 201, 202).—The artery may be tied in three places. A. At the upper part of the popliteal space. B. At lower part of the popliteal space. C. *From the front*, at the inner side of the limb. For the sake of experience, all should be practised on the dead body.

A. **At the Upper Part of the Popliteal Space** (Fig. 201).—The patient being rolled two-thirds on to his face, and the limb at first extended, an incision $3\frac{1}{2}$ inches long is made, in the line of the vessel, along the outer margin of the semi-membranosus, and then downwards and outwards to the centre of the space. The small sciatic nerve, if seen, should be drawn to one side; the deep fascia is then freely opened up, and the pulsation or the artery felt for at the inner margin of the semi-membranosus. The nerve is generally seen first, and this and the vein are to be drawn to either side with blunt hooks. The needle should be pased from the vein. A good deal of loose fat is usually in close contact with the vessels, and is liable to be a source of trouble wherever the artery is ligatured, especially in the dead subject.

FIG. 201.



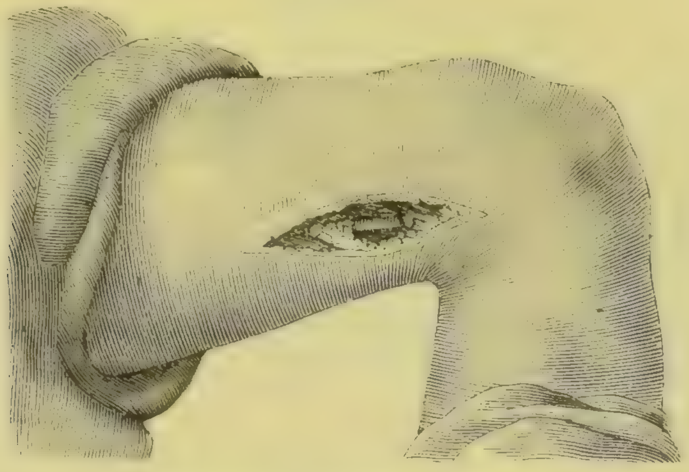
Above, the artery is shown under cover of the semi-membranosus. The small sciatic has been drawn aside with a blunt hook. Below, the vessel is exposed just above the heads of the gastrocnemius. The internal popliteal nerve is seen below outside the artery just before it crosses to the inner side.

B. **At the Lower Part of the Popliteal Space** (Fig. 201).—The limb being in the same position, an incision $3\frac{1}{2}$ inches long is made, in the line of the artery, from the centre of the popliteal space to the junction of the upper and middle thirds of the back of the leg. The external saphena vein and its nerve being avoided, the deep fascia is freely opened and the limb flexed. The exact interval between the heads of the gastrocnemius is next sought for. The following structures may now be met with overlying the artery, and must be drawn aside—viz., the plantaris, the sural arteries which run down on the vessel, and the posterior tibial nerve, which is often given off as high as this. The popliteal vein now lies to the inner side, together with the popliteal nerve, which is superficial to it, if this has not given off its branches. These structures should be drawn to either side, and the needle passed as is convenient.

C. **From the Front, at the Inner Side** (Fig. 202).—This operation might be useful in cases where hæmorrhage recurs after osteotomy at the lower end of the femur (p. 1173).

The following account is taken from Sir W. Mac Cormac (*Ligature of Arteries*, p. 110):—" Flex the knee and place the limb on the outer side. Make an incision 3 inches long immediately behind and parallel to the tendon of the adductor magnus downwards from the junction of the middle and lower thirds of the thigh. Divide the skin, superficial and deep fasciæ, avoid the long saphenous nerve, seek the tendon of the adductor magnus, draw it forwards and the hamstring tendons backwards. The

FIG. 202.



The artery lies embedded in fat. Above it are some of the fibres of the adductor magnus. In the upper angle of the wound the sartorius has been drawn down.

artery will then be found surrounded by fatty areolar tissue. The nerve and vein do not necessarily come into view, being on the external aspect of the vessel."

CHAPTER V.

OPERATIONS ON THE LEG.

LIGATURE OF POSTERIOR TIBIAL ARTERY.—LIGATURE OF ANTERIOR TIBIAL ARTERY.—LIGATURE OF PERONÆAL ARTERY.—AMPUTATION OF LEG. —OPERATION FOR NECROSIS.—TREATMENT OF COMPOUND FRACTURE.

LIGATURE OF THE POSTERIOR TIBIAL ARTERY.

Indications.—Very rare.

i. Chiefly Wounds.—Mr. Cripps,* in a very valuable paper, divides up the sources of hæmorrhage from the upper two-thirds of the posterior tibial into (1) hæmorrhage after amputation; (2) hæmorrhage from injury to the vessels in continuity.

1. Hæmorrhage after Amputation.—This is usually due to a diseased condition of the vessels, and to the fact that the vessels, lying between the bones, are now especially difficult to take up. If from their constantly breaking away it is found impossible to deal with them, the limb should at once be amputated above the knee. If the hæmorrhage occurs later on, well-adjusted pressure (p. 1063) should be carefully tried, aided or followed by ligature of the femoral or by amputation higher up.

2. Hæmorrhage from Wounds of the Tibials in Continuity.—Three chief causes may lead to this:—(*a*) Incised wounds. (*b*) Punctured wounds. (*c*) Wounds other than punctured or incised. Four methods of treatment are open to the surgeon—viz., (*a*) Pressure and bandaging. (*b*) Ligature of both ends of the vessel. (*c*) Ligature of the femoral. (*d*) Amputation.

(*a*) *Incised Wounds.*—If this is seen soon after its infliction the bleeding-point should be sought for and tied, the wound being enlarged, if needful. If sloughing and extravasation of blood have taken place, amputation will probably be the wiser course, though if the patient decide to run the risk, an attempt may be made to save his limb by making free incisions, providing drainage, plugging the wound (rendered as far as may be aseptic with irrigation and iodoform) with dry gauze, bandaging evenly and firmly, and tying the femoral in Hunter's canal.

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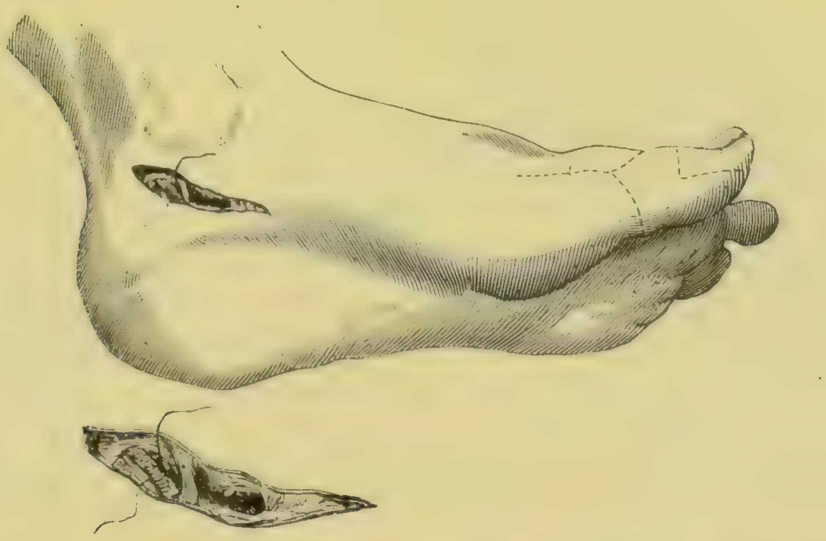
* *St. Barthol. Hosp. Reports*, vol. xi. p. 94; *Dict. of Surg.*, vol. ii. p. 626.

FIG. 203.



Ligature of the posterior tibial artery at the inner ankle. The incisions in amputation of the great toe at the metatarso-phalangeal and the inter-phalangeal joints are also shown.

(*b*) *Punctured Wound.*—If this is deep, and the vessel injured uncertain, the question of treatment is a very serious one.* Mr. Cripps shows that, in the majority of instances, pressure deserves a fair and thorough trial. If it is useless or prejudicial to other treatment, either the femoral must be tied or the wound enlarged to secure the wounded vessel. Between these operations the features of the particular case must decide. If pressure is made use of, it should be applied methodically and with intelligent purpose (p. 1063), and so that it needs no alteration or repetition.

(*c*) *Wounds other than Punctured or Incised—viz., Injury to the Vessel from Fracture or Gunshot Wound.*—In many cases conditions will be present which will call for amputation—viz., the severity of the crush; the extent of the comminution; injury to the nerves or to both arteries, as evidenced by the condition of the foot; and the age or the health of the patient. In most of these cases, as an attempt to find the vessel involves great difficulty and danger, and the probabilities of success diminish as the interval between the infliction and treatment of the injury increases, ligature of the femoral would be less hazardous than any interference with the wound. But amputation will frequently be needed. The above remarks apply to compound fractures; an instance of successful ligature of a lacerated femoral co-existing with a simple fracture of the leg is given at p. 1058.

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* Where the wound has passed obliquely, Dupuytren's words should be remembered. They refer to hæmorrhage from the calf caused by a pistol-bullet. "Should a ligature be placed on the ends of the divided vessel? But what were those vessels? Was it the anterior or posterior tibial, or the peronæal or the popliteal? Was it several of them at the same time? Should they be attacked before or behind?"

ii. Small traumatic aneurisms.

iii. The posterior tibial may be tied low down, together with the dorsalis pedis, for certain wounds of the sole or for some vascular growths of the foot.

LINE AND GUIDE.—A line drawn from a point at the lower part of the centre of the popliteal space * to one midway between the tendo-Achillis and the internal malleolus.

RELATIONS.—These differ according as the vessel is tied—(A) in the middle of the leg, (B) in the lower third of the leg, (C) at the inner ankle.

A. RELATIONS IN THE MIDDLE OF THE LEG :—

SUPERFICIAL.

Skin; fasciæ; branches of saphenæ veins and nerves.
Gastrocnemius; soleus; plantaris.
Special fascia; transverse branches of venæ comites; tendinous origin—arch of soleus (above).

OUTSIDE.		INSIDE.
Vena comes. Posterior tibial nerve which has crossed above from the inner side.	Posterior tibial.	Vena comes. Posterior tibial nerve (above).

BENEATH.

Flexor longus digitorum.
Tibialis posticus.

B. RELATIONS IN LOWER THIRD OF LEG :—

SUPERFICIAL.

Skin; fasciæ; superficial veins and nerves.

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* This point, representing the lower border of the popliteus, would be about 2½ inches below the knee-joint.

Outside.		Inside.
Vena comes.		Vena comes.
Posterior tibial nerve.	Posterior tibial.	
Tendo-Achillis.		

Beneath.

Flexor longus digitorum.
Tibia.

C. Relations at Inner Ankle :—

Superficial.

Skin ; fasciæ ; branches of internal saphena vein and nerve.
Internal annular ligament.

Outside.		Inside.
Vena comes.		Vena comes.
Flexor longus pollicis.	Posterior tibial.	Flexor longus digitorum ; tibialis posticus.
Posterior tibial nerve.		

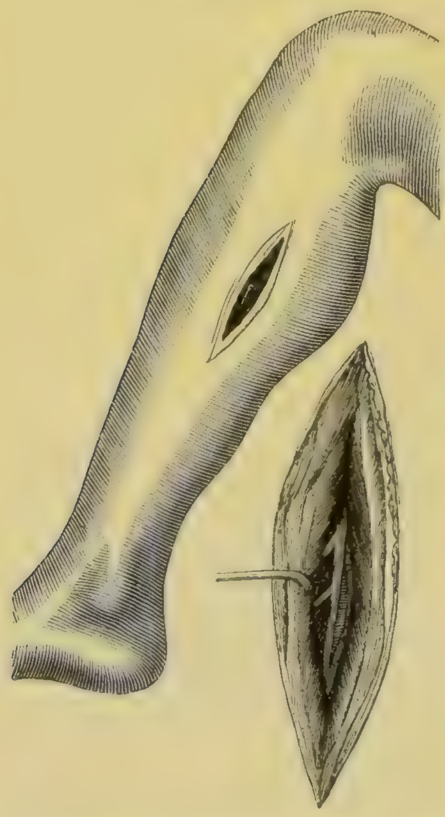
Beneath.

Internal lateral ligament.

Operation in Middle of Leg (Figs. 204, 205).

The parts being cleansed, the knee flexed, and the limb supported on its outer side, the surgeon, standing or sitting on the inner side, makes an incision 3½ inches long, parallel with the centre of the inner border of the tibia ; and ½ or ¾ inch behind it, according to the size of the limb. This incision divides skin and fasciæ. If the internal saphenous vein is met with, it must be drawn aside with a strabismus hook ; any of its branches may be divided between two chromic-gut ligatures. The deep fascia is then freely slit up, and the inner edge of the gastrocnemius defined and drawn backwards. This will expose the soleus, the tibial attachment of which is to be cut through, any sural artery being at once secured. The incision through the soleus should be 3 inches long and quite ½ inch from the tibia ; as the fibres are divided, the central membranous tendon will come into view, and must not be confused with the special deep fascia or intermuscular septum over the deep flexors. Usually, before this comes into view, some additional fibres have to be divided. When this is done, the above special fascia must be identified stretching between the bones. The wound must be carefully dried, and well opened out with retractors, and exposed with a good light at this stage. The deep fascia being opened carefully, the nerve usually comes into view first, the artery lying a little deeper and more internal. The venæ comites should be separated as far as possible, but rather than puncture them and cause hæmorrhage at this stage, or waste time, the surgeon should tie them in. The needle should be passed from the nerve. To facilitate this, the knee should be well flexed, and the foot also flexed downwards so as to relax the muscles thoroughly. The ligature will lie below the peronæal artery.

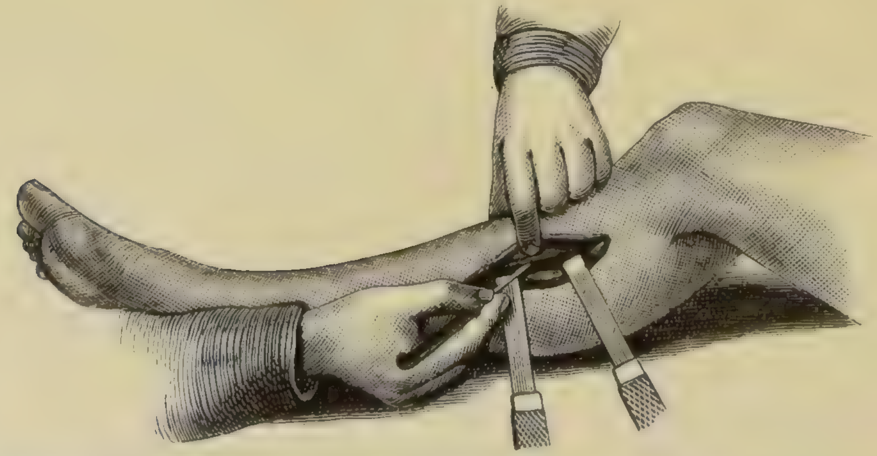
FIG. 204.



The position of the incision is shown on the figure to the left. That to the right shows the parts on a larger scale. The outer border of the gastrocnemius is seen to the right beneath the cut fat. One of the edges of the cut soleus is shown retracted. One of the venæ comites appears internal to the artery, the nerve lying to its outer side.

Operation in Lower Third of Leg.—The limb and the operator being in the same position as at p. 1117, an incision, 2½ inches long, is made through skin and fasciæ, parallel with the inner border of the tibia, and midway between it and the tendo-Achillis; after the deep fascia has been opened, another layer, tying down the deep flexor tendons, will require division. The artery here lies between the flexor longus digitorum and pollicis, surrounded

FIG. 205.



Ligature of the posterior tibial at the middle of the calf. The inner head of the gastrocnemius is drawn backwards by retractors. The left index raises the anterior lip of the wound while the soleus is divided, perpendicularly to its surface. (Farabeuf.)

by venæ comites. The needle should be passed from the nerve, which lies external. If the incision is made too high, some of the lowest fibres of the soleus will require detaching from the tibia; if too low, the internal annular ligament would be opened. The sheaths of the flexors (their synovial investment commences about 1½ inch above the internal malleolus) should not be interfered with.

Operation at the Inner Ankle (Fig. 203).—The limb and operator being placed as before, a curved incision, 2 inches long, is made, ¾ inch behind the internal malleolus. Skin and fasciæ being divided, and any branches of the internal saphena vein tied, the internal annular ligament is divided and the artery found, closely surrounded with its veins. The nerve lies externally, and the needle should be passed from it. The artery is so superficial here, that the veins can be easily separated. The nerve has occasionally bifurcated higher up.

LIGATURE OF THE ANTERIOR TIBIAL.

Indications.—These are very few, and resemble so closely those already given for the posterior tibial—viz., wounds and traumatic aneurism—that there is no need to go into them again here.

In the course of 1887, I had occasion to tie the anterior tibial in its lower third for profuse hæmorrhage from a compound fracture not arrested by pressure. There was a compound comminuted fracture of the right leg in the lower third from a fall of 4 cwt. upon the limb. The upper end of the artery was found with some difficulty, owing to the pulped-up condition of the soft parts. Having failed to find the lower end, I was about to expose the dorsalis pedis, and, trusting to antiseptic precautions, trace this up to the anterior tibial, when, an urgent strangulated hernia being admitted, I plugged the wound, all the undermined parts being previously laid freely open. No recurrence of bleeding took place, and the man (aged forty-four) made an excellent recovery, aided by his temperate life and patient ways, the freedom with which the wound was laid open, this preventing all retention of discharges, the use of dry gauze dressings only changed at rare intervals, and, not least, the fact that iodoform was thoroughly dusted in.

Dr. Shepherd, of Montreal (*Annals of Surgery*, No. 1, p. 7), gives another, but more difficult, case in which the compound fracture was about the junction of the middle with the upper third of the leg. The bleeding was first arrested by pressure, on the fourth day a traumatic aneurism appeared. The artery was exposed with difficulty,* and found partly divided, two ligatures were applied, and the patient made a good recovery.

LINE AND GUIDE.—From a point midway between the head of the fibula and the outer tuberosity of the tibia to the centre of the front of the ankle-joint. The outer edge of the tibialis anticus.

RELATIONS :—

SUPERFICIAL.

Skin ; fasciæ : cutaneous branches of saphenous veins and nerves, and (below) musculo-cutaneous nerve.
Tibialis anticus and extensor longus digitorum (above), overlapping.
Tibialis anticus and extensor longus pollicis (below), overlapping.

OUTSIDE.	Anterior tibial artery.	INSIDE.
Extensor longus digitorum (above).		Tibialis anticus.
Extensor longus pollicis (below).		Vein.
Anterior tibial nerve.		
Vein.		

BENEATH.

Interosseous membrane.

Operation at the Junction of the Upper and Middle Third of Leg.—The knee being flexed and the limb supported upon its inner side, the surgeon having defined if possible the outer edge of the tibialis anticus,† sits or stands on the outer side of the patient, and makes an incision about 4 inches long in the line of the artery, beginning about 2 inches below the head of the tibia. This incision should lie (if the edge of the muscle has not been marked out) $\frac{3}{4}$ to 1 inch—according to the size of the leg—from the crest of the tibia, and should expose the deep fascia carefully so that the white line which marks the desired intermuscular septum may be looked for. This line is often whitish-yellow, and varies much in distinctness. If there is any difficulty in finding it, any bleeding points must be secured, and the deep fascia slit up over the line of the artery, and the finger-tip inserted to feel for the sulcus between the muscles. A third aid is almost constant, and that is a small muscular artery* which comes up between the tibialis and the extensor longus digitorum. The sulcus being found between the muscles (without tearing them), they are separated with the handle of a scalpel or a steel director, and retractors inserted, the outer one being hooked over the fibula. If the limb is a very muscular one, the deep fascia should be nicked transversely at the upper and lower extremities of the wound, and the parts more relaxed by bending the knee more and pressing the foot upwards. The finger now directed towards the interosseous space feels for the artery deep down in the bottom of the wound. The nerve should be drawn to the outer side. If much trouble is met with in separating the venæ comites they may be included.

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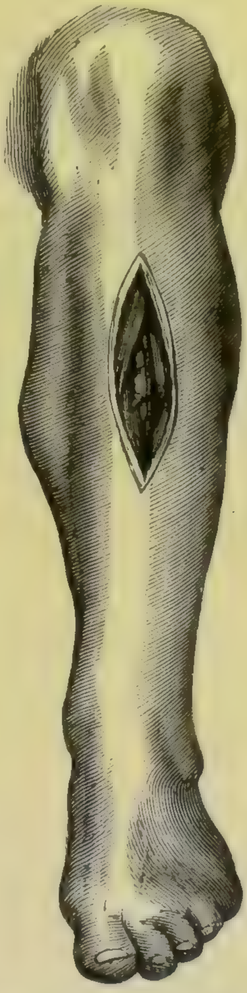
* Dr. Shepherd points out that, the injury to the vessel being just in front of the place where it pierces the interosseous membrane, if the artery had been completely torn through, it would have retracted through the opening, and ligature would have been impossible. Mr. Page (*Lancet*, 1887, vol. i. p. 522) gives a case of a traumatic aneurism of ten weeks' duration, after a stab, at the junction of the middle and lower third of the leg. The swelling had been poulticed and opened, with the result of hæmorrhage. Mr. Page, on clearing out the clots and opening up the swelling, was unable to find the anterior tibial artery. Hæmorrhage recurring, the leg was amputated. The patient recovered.

† The patient may put this into action just before the anæsthetic is taken.

FIG. 206.



The anterior tibial is seen with one of its veins lying between the displaced tibialis anticus and extensor longus digitorum. The muscular branch is shown, but rather too large.

Drainage being provided, and all hæmorrhage stopped, the wound is lightly dusted with iodoform, the muscles united with one or two chromic-gut sutures, and the wound closed, and the limb kept raised and flexed.

Operation at the Junction of the Lower and Middle Third of Leg.—An incision about 2½ inches long is made in the line of the artery, in the upper part; this incision will be about 1 inch from the tibia. The white line and the interval between the tibialis anticus and the extensor proprius pollicis are both looked and felt for. The deep fascia being divided and the muscles relaxed and retracted, the artery is found surrounded by its venæ comites. The needle must be passed from without inwards.

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* This is pointed out by Mr. C. Heath (*Oper. Surg.*, p. 47). I have found the same thing most helpful in the ligature of the ulnar in the middle third (p. 43).

LIGATURE OF THE PERONÆAL ARTERY.

Indications.—As these are extremely few, and as in the case of a wound of the vessel (which is very rarely met with) the best course would be to enlarge the wound, any formal operation for its ligature need only be very briefly described.

Relations.—The peronæal artery comes off from the posterior tibial about 1 inch below the popliteus, descends at first parallel with this artery but separated from it by the posterior tibial nerve; it then passes outwards towards the fibula and runs down between this bone and the flexor longus pollicis. In the upper part of its course it lies upon the tibialis posticus, and is covered by the soleus.

Operation.—To tie the artery when no wound is present to guide the surgeon, an incision, 3 inches long, should be made along the posterior border of the fibula with its centre at the junction of the upper and middle thirds of the leg. The gastrocnemius being drawn aside, and the soleus separated from its attachment to the fibula, the special deep fascia is slit up and the artery sought for close to the fibula.

AMPUTATION OF THE LEG.

Different Methods.

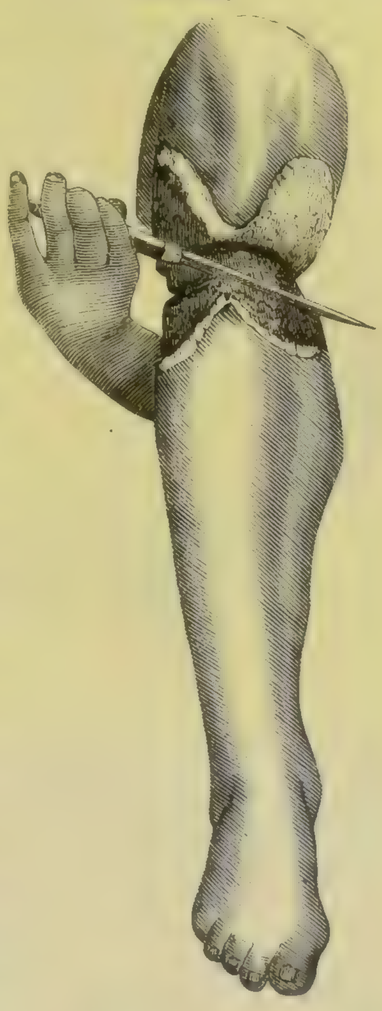
1. **Lateral Flaps** (Fig. 207). 2. **Teale's Rectangular Flaps** (Figs. 208, 209, 210). 3. **Antero-posterior Flaps of Skin.** 4. **Antero-posterior Flaps, Anterior of Skin, Posterior by Transfixion of Muscle.** 5. **Circular.**

I shall only describe the first two, as they will be found adapted to all emergencies, and to be devoid of the disadvantages of the others.

1. **Lateral Skin Flaps, with Circular Division of the Muscles, &c.**—This is, I believe, a method not well known beyond Guy's and those who have been taught there. It will not only be found most convenient at the time, but it also gives very satisfactory results afterwards. The blood-supply is well and equally distributed to the lateral flaps, one can be conveniently cut longer than the other, and they are more easily shaped and dissected up than antero-posterior skin flaps, while no mass of muscle is left to drag away from and expose the bones, as in the antero-posterior flaps, with the anterior of skin and the posterior by transfixion.

Operation (Fig. 207).—The femoral artery being commanded, the leg brought over the table, and the damaged or diseased parts wrapped in carbolized lint so as to give the assistant a firm hold and also to prevent his soiling the flaps later on, the opposite ankle is tied to the table. The surgeon standing to the right of the limb places his left index on the crest about an inch below the tubercle, and his thumb at a corresponding point behind in the centre of the limb. Looking over he inserts his knife close to the thumb and cuts on the side of the limb farthest from him a lateral flap broadly oval in shape and 3 inches long, ending at the index finger, from which point, without removing the knife, a similar flap is marked out ending on the back where the first began. The flaps are now dissected up of skin and fasciæ, and the muscles all cut through with a circular sweep of the knife at the intended point of bone-section, this sweep being repeated two or three times till the soft parts are all cleanly severed. The interosseous membrane is next divided, so that it shall not be frayed by the saw, and with one final, firmly drawn, circular sweep the periosteum is grooved for the saw.* This is then applied with the following *precautions*. The position of the fibula behind the tibia and its much smaller size must be remembered lest it be splintered. This may be avoided by rolling the leg well over on to the inner or outer side as the case may be, and placing the saw well down on the outer side so as to start the section of the bones simultaneously, and thus ensure complete division of the fibula before the tibia. This object may also be effected, if the leg is held in the ordinary position, by applying the saw to the tibia, and remembering, when this bone has been sawn half through, to depress the handle, and thus complete the section of the bones simultaneously. In either case the saw should be used lightly and

FIG. 207.



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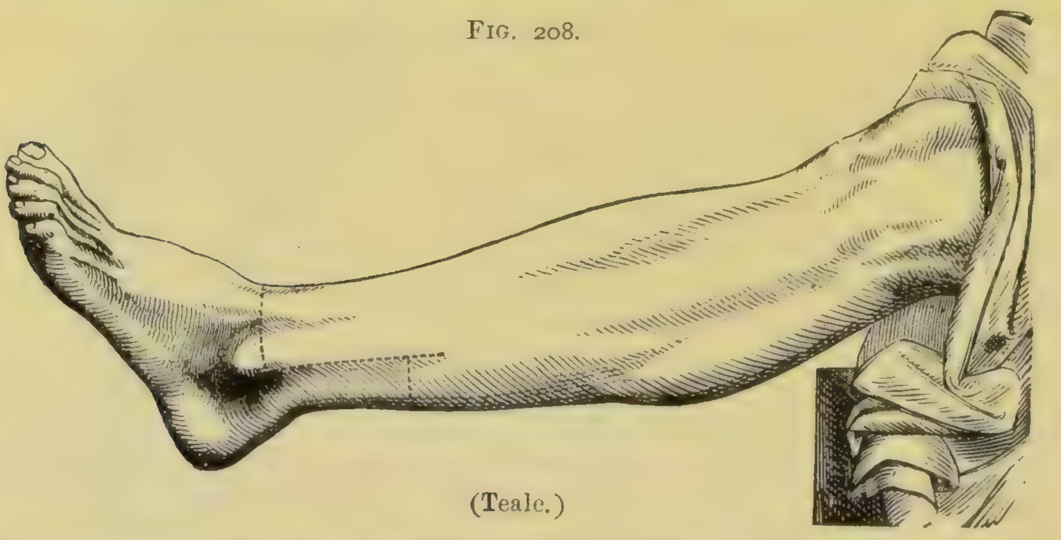
* Nowadays, with antiseptic precautions, the old need of periosteal flaps—viz., to keep pus, &c., out of the diploë and medullary canal—is no longer present. Furthermore, these flaps are very difficult to raise, unless inflamed, especially in the thin periosteum of adults.

quickly, with the whole length of the blade, and without jamming. As the sharp projecting angle of the crest tends to come through the anterior angle of the flaps, this may be sawn off obliquely after the bones are sawn.

Teale's Amputation by Rectangular Flaps (Figs. 208, 209, 210).

Advantages.—1. The covering for the bones is ample, and the flaps come together without tension.* 2. The way in which the flaps are united favours drainage during healing, and provides a scar well out of the way of pressure. 3. The stump bears pressure well.

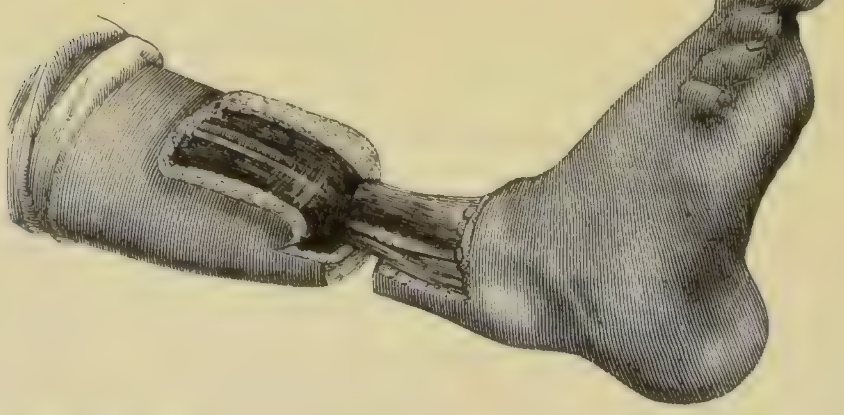
FIG. 208.



(Teale.)

Disadvantages.—1. It is an expensive method, involving a high section of the bones. 2. The long anterior flap may slough. 3. If performed with the accuracy of its introducer, it involves more time than that by lateral flaps (p. 1123), and is, thus, not suited to cases of shock.

FIG. 209.



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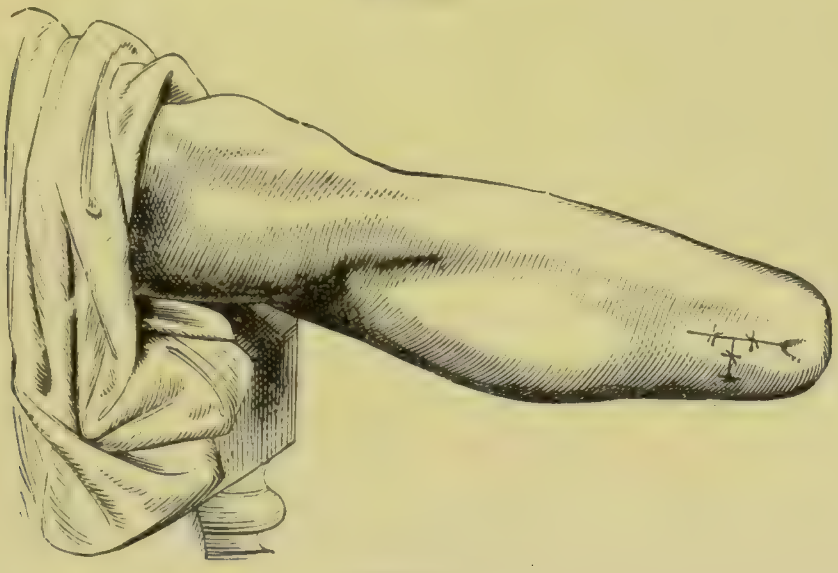
[*] Save when infiltrated, the difficulty of getting the anterior flap into position is then often considerable.

Operation.—The preparatory steps, and the position of the operator and patient, are as at p. 1123. The surgeon having measured the circumference of the limb at the spot where he intends to saw the bones, and placing here his left index and thumb on the tibia and fibula, traces out a long rectangular, anterior flap which is to be, both in its length and breadth, equal to half the above circumference.* In tracing this flap the incision starts from the index finger, runs down along the bone farthest from the surgeon for 4½ inches (if the circumference at the site of bone-section is 9 inches), then crosses the limb, cutting all the structures down to the bones—this end of the flap being also 4½ inches wide—and then travels up along the opposite bone to the surgeon's thumb. The anterior flap is then dissected up partly with the knife—*e.g.*, on the inner side, where the scanty coverings must be raised as thick as possible and without scoring, partly with the knife and partly with the finger on the outer aspect, where the extensors, anterior tibial vessels and nerve must be stripped up, uninjured, from the interosseous membrane. The posterior flap, which has been previously marked out fully ¼ in length of the anterior, is now cut by the surgeon looking over the limb and passing his knife beneath it, and cutting everything down to the bones. It is next raised as high as the point where the bones are to be sawn. The interosseous membrane and the bones are then attended to with the precautions given at p. 1123.

FIG. 210.



(Teale.)

The vessels being secured and drainage provided, the anterior flap is folded over the bones (care being taken not to double it too sharply), its cut end stitched to the cut end of the posterior flap, and the portion folded below the bones stitched to that folded above them (Fig. 210).

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* In the lower third, where the leg tapers quickly, care must be taken to keep this flap of the same width below as it is above.

SEQUESTROTOMY.

As the removal of necrosed bone is most frequently required in the leg, the above operation will be described here.

Indications.—The question will often arise as to whether the case is ripe for operation. The chief points bearing upon this, and the looseness of the sequestrum, are—(1) The time that has elapsed since the beginning of the illness; thus, two to three months will probably be required in the case of the tibia, but more likely six in that of the femur; (2) the age and general health* of the patient. The younger the patient, and the more vigorous his vitality, the more rapidly will the sequestrum become detached; (3) the size of the sequestrum. The larger and more total the sequestrum, the slower will be the process; (4) the feel of the sequestrum. When steel probes announce this to be dry, hard, and ringing, exploration is justified, especially if the sequestrum can be felt to be loose or depressed by the probe; (5) the size and amount of the new shell of bone. The more distinct this is, the more probable is it that the process of separation is complete.

Operation.†—This should be always conducted antiseptically, with the spray, when practicable, or with careful irrigation with a solution of mercury perchloride (1 in 2000), and for these reasons—(*a*) to prevent any risk of setting up septic osteo-myelitis; (*b*) to diminish the amount of suppuration, and so the risk of necrosis after the interference with the periosteum which is entailed by the operation.

The limb being rendered evascular by vertical elevation while the patient is taking the anæsthetic, and the application of Esmarch's bandage, is firmly supported on sand bags, steel probes are placed in the cloacæ which mark the limit of the disease, and with a strong-backed scalpel the surgeon makes an incision between them on the inner surface of the tibia down to the bone. If only one sinus is present, this will probably be taken as the centre of the incision. The soft parts being reflected, with every care of the periosteum, partly with the finger, partly with a blunt dissector, the new sheath of bone, spongy and vascular, is thoroughly exposed with a chisel and mallet. This is then cut into and sufficiently removed so as to expose its cavity completely from end to end.* The sequestrum is now removed with sequestrum-forceps, or prised out with an elevator. If too large, it must be divided with cutting-forceps. The bed of ill-formed granulation-tissue in which the sequestrum lay is then carefully examined for any small bit which may be concealed, and this tissue is all scraped away with a sharp spoon. When the surgeon is satisfied that all the mischief has been removed, he plugs the resulting cavity carefully with strips of dry gauze, dusted with iodoform, bandages these dressings firmly on while the limb is elevated, and not till then removes the Esmarch's bandage. If the bandage is removed before the dressings are applied, such free venous oozing takes place that the plugs are at once loosened and rendered inefficient, and the wound has to be redressed shortly. The limb is kept raised on a back splint and an injection of morphia given.

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* Freedom from syphilis and phthisis will be noted.

† It is supposed here that the sequestrum is one of considerable size.

Two questions with regard to sequestrotomy require to be alluded to—viz., that of performing **early sub-periosteal resection**—*i.e.*, as soon as the bone is dead, and before any shell of new bone has formed around it, and that of **amputation.**

Early Sub-periosteal Resection.—Mr. Holmes (*Surgical Treatment of Children's Diseases*, p. 385) has discussed this question, and given the following advantages and disadvantages:—"The advantages of sub-periosteal resection of the shaft of the bone over the expectant treatment are: (1) That it takes away what is a source of very acute and dangerous constitutional irritation, and (2) that it avoids the embarrassment of future operations, and the tediousness of the convalescence which follows on the invagination of a large sequestrum." The drawbacks are chiefly two: the almost certainty of more or less shortening, and the great probability of mischief spreading into the nearest joint.

Antiseptic treatment will probably remove this second drawback—*i.e.*, after the operation there will be no acute suppuration to make its way into a joint. The certainty of shortening which takes place here, although the fibula is present to act as a stay, and to prevent any approximation of the ankle to the knee, is a much more serious drawback, and when coupled with the fact that the patients who would be submitted to early sub-periosteal resection are often only just recovered from a very prostrating illness seems to me to be strongly against it in most cases.

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* Mr. Howse (*Brit. Med. Journ.*, 1874, vol. i. p. 475) lays great stress on the need of this. The new bone should be removed as far as a probe can be passed upwards or downwards inside it, so as to make the whole easily granulate up from the bottom. Otherwise, the part that is not laid open will very likely persist with a sinus. Furthermore, laying the whole cavity open not only ensures its granulating up from the bottom, but also allows of the removal of all ill-formed granulation material.

Question of Amputation.—The following are some of the conditions which will call for this operation: (1) When the patient's vitality is so low as to be unable to repair the wound of an early sub-periosteal resection, or to stand the tax upon it of the expectant treatment; (2) When the epiphyses are perforated, and the knee or ankle (especially if both are affected) are involved; (3) If a condition of chronic septicæmia is present; (4) If the general health, from the presence of phthisis, lardaceous disease, or syphilis, is much impaired.

TREATMENT OF COMPOUND FRACTURES.*

The following **special points for consideration** arise here—viz., (1) The reduction of protruding fragments and the treatment of splinters; (2) The best mode of dressing the wound; (3) Complications; (4) The question of amputation.

(1) *Protrusion of Fragments.*—It is usually the upper one which protrudes. The difficulty of reduction is in proportion to the size of the wound, the length of the protruding bone, and the amount of spasm. If reduction cannot be effected by moderate extension and dextrous manœuvring, the wound must be enlarged, and if this is not sufficient, part of the bone must be removed with a narrow-bladed saw (Adams' osteotomy saw will be found very useful), care being taken to separate the periosteum first, and to protect the soft parts with a blunt dissector passed under the bone and by retractors. If the bone is splintered, some judgment is required as to what pieces to remove. Those which are still adherent by their periosteum should be left. Those completely torn away must be removed, whether they carry their periosteum or not. As to a third set partly adherent, partly not, these, as a rule, partially die in proportion to the injury to their periosteum, and keep up for a long time irritation, and delayed union with, perhaps, suppuration, erysipelas, &c. They must, therefore, as far

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* From the frequency with which these occur in the leg this subject will be treated here. The account is taken largely from the article "Fractures," *Syst. of Surg.*, vol. i. p. 421, which I rewrote in 1882.

as practicable, be removed, counter-openings being made for the purpose, when they cannot be reached through the wound.

(2) In *dressing the wound* the one great object is to convert the fracture as soon as possible into a simple one. In less severe cases, sealing a small clean cut wound at once with dry gauze, and collodion, and iodoform, or tinct. benz. co., will be sufficient. But in those cases, common enough in large hospital practice, where the wound is extensive and lacerated, and accompanied by much contusion of the soft parts, with abundant blood extravasation, with much comminution of fragments and injury to the periosteum, or where the fracture is complicated with a dislocation, the antiseptic method will be found to give the best results in the largest number of cases.

While an anæsthetic is given, the limb is cleansed with lint, and 1 in 2000 solution of hyd. perch. An Esmarch's bandage being applied, and the wound enlarged, the bone which requires it (*vide supra*) is removed, any vessels secured, and a 1 in 30 solution of carbolic acid is injected into all the recesses of the wound by means of a syringe with a gum-elastic catheter attached by tubing. Prof. Lister has shown that this must not be done too vigorously, as extensive injection of the cellular interspaces may set up serious irritation and sloughing. For this reason he advises that the outlet of the wound should not be held closed around the catheter, but left freely open during the syringing. Irrigation with mercury perchloride solution should always be employed, any very undermined parts slit up, and free counter-openings made for drainage. All hæmorrhage being arrested, and any torn nerves pared and sutured, the recesses of the wound are dried with sponges in holders; powdered iodoform* and boracic acid are then dusted in, dressings of dry sal-alembroth or iodoform gauze applied, and the limb put up either in a back and two side splints, or, according to Mr. Croft's directions, in plaster-of-Paris. Of the two I prefer the former in severe cases for the first week; infrequent dressings, wherever practicable, are most essential.

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* This most valuable drug is not sufficiently used in these cases. I may briefly mention three cases in which limbs were, I think, saved by it. One was a very severe compound fracture of the femur in a man, aged forty-six, who fell twenty-two feet on to the banks of the Thames, striking a stone buttress as he went down. I saw him about an hour after the accident. The fragments were much displaced and overlapping, the lower one being also split vertically, but not as far as the knee-joint. The ends of both were bare, and the vastus externus and hamstrings were lacerated, the injury having been made greater by the patient having been lifted off the mud on to which he fell into a boat, and then into a cab. Ether having been given, the external wound, through which the vastus externus protruded, was freely enlarged, and its recesses well washed out with 1 in 30 carbolic-acid solution, as advised above. About ʒj of iodoform was then carried down right between the fragments by means of the finger and a narrow spatula, and two large drainage-tubes inserted. An aseptic result was secured from the first and maintained throughout by the dresser (Mr. J. H. Lister), the man making

(3) *Complications.*—My space will only allow me to enumerate these. They are local and general. The former include pruritus, vesicles, ecchymosis, suppuration, œdema, phlebitis, gangrene, ostitis, caries, necrosis, muscular spasms, dislocations, and implication of a neighbouring joint. The general complications are such as are common to all injuries—viz., traumatic fever, delirium, erysipelas, septicæmia, pyæmia, hectic, tetanus, jaundice, and retention of urine; in older patients a tendency to hypostatic congestion and broncho-pneumonia, and finally, in a few cases, pulmonary fat-embolism.

(4) *Question of Amputation.*—The following are amongst the conditions requiring primary amputation:—(1) When a limb is torn off by a cannon-ball, a portion of shell, or by machinery. (2) When the division of the soft parts is nearly complete, except in the case of a clean cut across the phalanges, metacarpus, or metatarsus; even the forearm may occasionally be saved under similar circumstances. (3) When there is much actual loss of soft parts, as when one side of a limb is torn away, or the skin is extensively peeled off. (4) When, with or without great comminution of the bones, there is much bruising and laceration of the soft parts, with protrusion of muscular bellies, and extensive tearing up of deep planes of areolar tissue. (5) In some cases when the principal artery and nerves of the limb are both divided, thus, in the case of the lower limb, primary amputation will usually be required. (6) In certain cases of severe hæmorrhage, primary or secondary. On this subject I must refer my readers to the remarks already made at p. 1115. (7) Some cases of compound fracture of large joints—viz., when one bone is shattered or more than one is broken; when there is much laceration of the ligaments; when, in addition to comminution of the bones, there is much contusion of the soft parts, especially if complicated with division of an artery; when the foreign body which has caused the fracture remains in the joint, or, projecting into it

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an excellent recovery. The second case was that of a compound comminuted fracture of the leg, with wound of the anterior tibial artery (mentioned at p. 1119). The third occurred in a boy with compound separation of the lower epiphysis of the tibia, in which two inches of the protruding diaphysis were removed. The case did so well after the introduction of iodoform and the other precautions already given, that the first dressings (dry sal-alembroth gauze) were not removed till the eighth day, and the lad recovered with an excellent limb.

from its bed in the bone, cannot easily be removed, or when there is much damage to the articular surfaces. It will be understood that all these forms of injury are most fatal when affecting the knee or hip; in dealing with other joints much greater latitude may be allowed.

Finally, before deciding on amputation, the surgeon must take into consideration, in addition to the above points which concern the fracture itself, any general information to be gained about the patient himself. Thus, the age, constitution, habits, any sign of visceral disease, and the appearance of the patient, are all points of material importance in coming to a decision between amputation and an attempt to save the limb. Thus, to make my meaning clearer, there are no more anxious cases than severe compound fractures in dwellers in large towns, who are past middle life, flabbily fat, with dilated venules about the cheeks and nose, whose conjunctivæ are slightly jaundiced, the urine of low specific gravity and perhaps albuminous.* The surgeon must here bear in mind that saving the patient's life is, after all, of more importance than the preservation of his limb.

In performing amputation in these cases of compound fracture it is always to be remembered that the injury is not so localized as would appear from the surface; thus, in compound fracture of the leg there is often extensive loosening of the skin from the deep fascia, and extravasation of blood into the deep planes of connective tissue for some distance above, the knee-joint being perhaps full of blood, and its cartilages bruised. In such cases if amputation be performed just above the injury, sloughing and separation of the flaps will inevitably follow. On the other hand, in cases of severe compound fracture of the thigh, where amputation is required high up, it will be found better practice to amputate, in part at least, through injured tissues.†

If, in addition to the fracture, there are serious injuries to other organs, immediate amputation is useless or injurious. The only chance of recovery here is afforded by secondary amputation, after the early dangers are past.

Secondary amputation may be required for profuse suppuration with hectic, for gangrene, or uncontrollable hæmorrhage. The decision must here be made according to the needs of each case. The surgeon must, if possible, wait till the traumatic fever and constitutional disturbance are subsiding, till the temperature has begun to fall, and till all redness, erysipelas, and sloughing have ceased. On the other hand, if the operation be deferred till the powers of the patient are running down from profuse suppuration and hectic, and till confirmed asthenia has set in, the period of performing it will, very probably, have passed away.

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* Note will also be taken of the occupation, as in brewers'-draymen and commercial travellers.

† Thus, in the case of a young railway porter, whose thigh was smashed by a railway accident at Epsom, I performed amputation at the level of the lesser trochanter, in preference to the hip-joint. The damaged flaps sloughed, as I expected, but the patient made a good recovery, after the removal of some dead bone. The precautions already given against shock (p. 1031) will, of course, be taken in these cases.

At a still later period the operation may be desired by the patient, if, in consequence of non-union, incurable deformity, or tedious bone disease, the limb has become an incumbrance to him. Some of these conditions may, of course, be treated by resection, osteotomy, &c.

CHAPTER VI.

OPERATIONS ON THE FOOT.

LIGATURE OF THE DORSALIS PEDIS.—SYME'S AMPUTATION.—ROUX'S AMPUTATION.—PIROGOFF'S AMPUTATION. — SUB-ASTRAGALOID AMPUTATION.—EXCISION OF THE ANKLE.—EXCISION OF BONES AND JOINTS OF THE TARSUS.—EXCISION OF ASTRAGALUS.—EXCISION OF OS CALCIS.—MORE COMPLETE TARSECTOMY FOR CARIES.—REMOVAL OF WEDGE OF BONE FOR TALIPES.—CHOPART'S AMPUTATION.—TRIPIER'S AMPUTATION. — AMPUTATION AT METATARSO-PHALANGEAL JOINT.—AMPUTATION OF THE TOES.

LIGATURE OF THE DORSALIS PEDIS (Fig. 211).

Indications.—Very rare. (1) Wounds. (2) Together with the posterior tibial in the lower third, for hæmorrhage from punctured wounds of the sole resisting other treatment. (3) For some vascular tumours of the foot.

LINE.—From the centre of the ankle-joint to the upper part of the first interosseous space.

GUIDE.—The above line and the adjacent tendons of the great and second toe.

RELATIONS :— IN FRONT.

Skin, fasciæ ; branches of saphenæ veins, and of musculo-cutaneous and anterior tibial nerves.

A special deep fascia continuous with the sheaths of the adjacent tendons.

Extensor brevis (innermost tendon).

OUTSIDE.	INSIDE.
Vein.	Vein.
Anterior tibial nerve.	Extensor longus pollicis.
Extensor longus digitorum.	

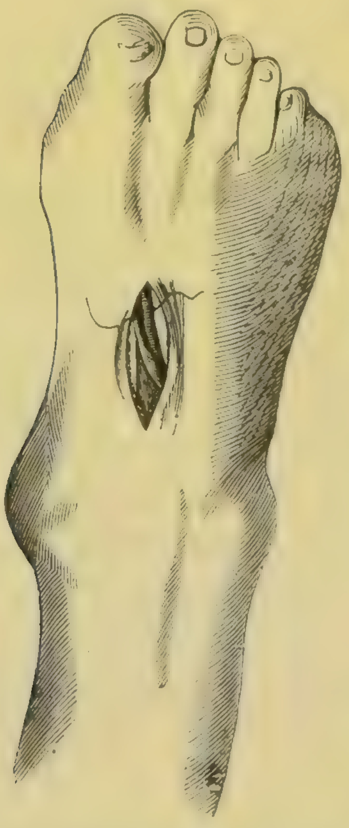
Dorsalis pedis artery.

BEHIND.

Astragalus ; scaphoid ; internal cuneiform.

Operation (Fig. 211).—The foot being cleansed, an incision about 1½ inch long is made in the line of the artery, in the lower part of its course, commencing about 1½ inch below the ankle-joint. Skin and fasciæ being cut through, and any superficial veins tied with chromic gut or drawn aside, one of the long extensors is found (its sheath is not to be opened), and the strong fascia given off from them opened. If the extensor brevis cross the artery at this spot it must be drawn aside. The ligature should be passed from without inwards.

Fig. 211.



The dorsalis pedis (too much of the artery is shown cleaned) is seen lying between the extensor longus pollicis and digitorum, and crossed by the innermost tendon of the short extensor.

SYME'S AMPUTATION

(Figs. 212–215).

An amputation at the ankle-joint by a heel-flap, with removal of the malleoli.

Operation.—Hæmorrhage being controlled, any sinuses present scraped out, the foot bandaged,* and held at right angles to the leg, the surgeon, standing a little to the right, but so as easily to face the sole, makes, with a short, strong knife, an incision (in the case of the left foot) from the tip of the external malleolus to a point ½ inch below† the internal one, this incision not going straight across the sole as in Pirogoff's amputation, but pointing a little backwards towards the heel.‡ The horns of this incision are then joined by one passing straight across the joint,§ and severing everything at once down to the ankle-joint. The foot being now strongly bent downwards, the lateral ligaments are severed, and the joint thus fully opened. The foot being slightly twisted from side to side, the soft parts on either side are carefully divided, especial precautions being taken on the inner side to cut the posterior tibial artery as long as possible (to ensure getting below the internal calcanean) and not to prick it afterwards.

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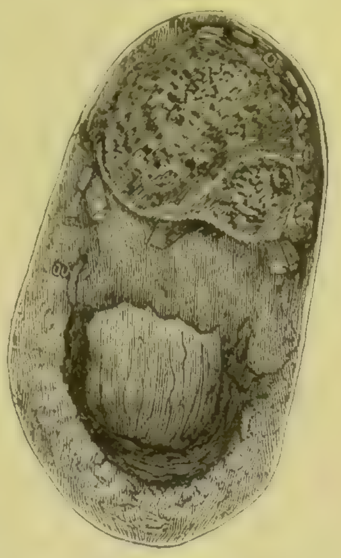
* So as to give a grip, and also to prevent the assistant's hands from being septic when he supports the stump a little later.

† The directions usually given are to go behind this point as well as below it, but by following the above course the posterior tibial is more likely to escape section before its time, and the flap will be found sufficiently symmetrical.

‡ If the foot is small, and still more if the parts on the dorsum are damaged, the plantar incision should run straight across. On the other hand, the more prominent the heel, the more should the flap point backwards. This will facilitate turning the flap over the heel.

§ Or with a very slight convexity. If anything of a flap is made here, the operator is liable to get away from the joint and cut into the neck of the astra-

FIG. 212.



The parts in a Syme's amputation before the heel-flap is adjusted (left side). The bones are shown above with the extensor tendons and the anterior tibial vessels, and, below, the tendo-Achillis. On the inner side the flexor tendons and the plantar arteries are shown cut; on the outer side, the peronæi. This Fig. should be contrasted with Fig. 217.

The foot being still more depressed, the upper non-articular surface of the os calcis comes into view, and then the tendo-Achillis. This is severed, and the heel-flap next dissected off the os calcis from above downwards, especial care being taken to cut this flap as thick as possible, not to score or puncture it, but rather to peel it off the bone with the left thumb-nail kept in front of the knife, aided by touches of this.*

The foot having been removed, the soft parts are carefully cleared off the malleoli, and a slice of the tibia sufficiently thick to include these prominences removed. This slice should in any case, to avoid shortening, be the thinnest possible. Prof. Macleod† has recommended to remove only the malleoli, leaving the cartilage on the under surface of the tibia. I have followed his advice in my last five cases—in one, a private patient of sixty-three, where I had not the carrying out of the after-treatment, the cartilage exfoliated. The others were all younger patients—in one, in addition to the disease of the tarsus, active secondary syphilis was present; in all, in spite of pulpy sinuses in three which required repeated scraping out (Fig. 215), no exfoliation took place. If the stump can be kept aseptic, Prof. Macleod's advice seems to me well worth

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galus. Moreover, the parts are not well nourished, especially if sinus-riddled or undermined.

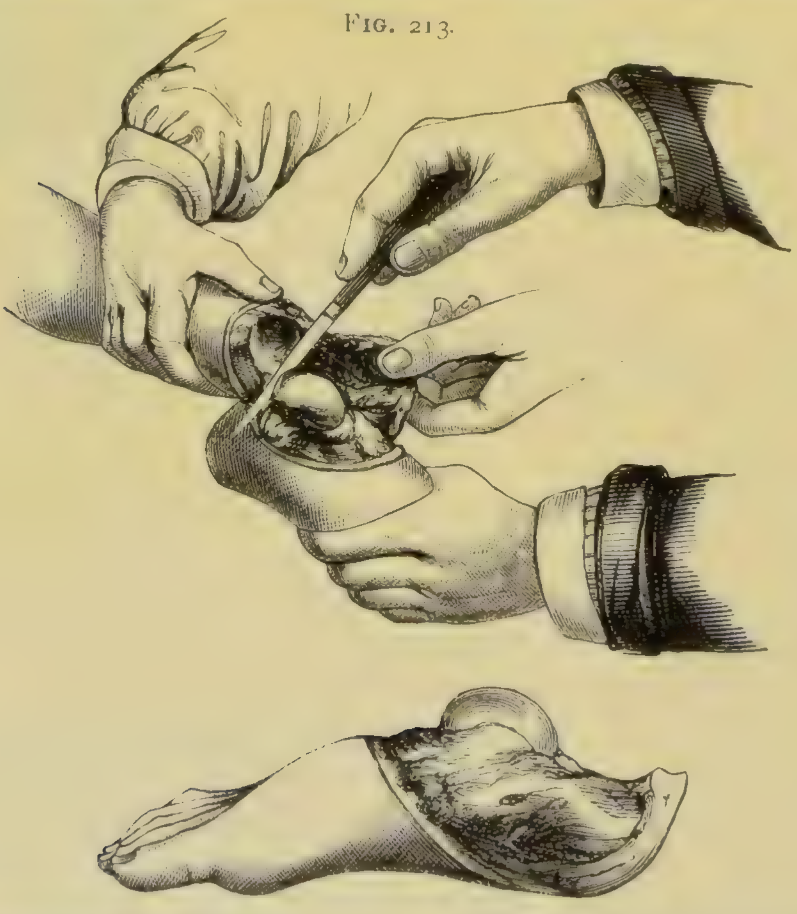
* If, in a young subject, the epiphysis comes away in the heel-flap, it may remain there if the parts are healthy. The same course may be followed with the periosteum, if it is found loose and peels easily away. Mr. Johnson Smith when amputating both feet for frost-bite, left the periosteum on one side. On the other no attempt was made to save it. The first stump was much larger than the other, harder, and more rounded; more like that of a Pirogoff's amputation.

† *Brit. Med. Journ.*, 1869, vol. ii. p. 239.

a further trial, as it entails less shortening of the limb and does away with the risk of septic phlebitis, which may be brought about by opening the cancellous tissue. If, on the other hand, the lower end of the tibia is diseased, it must be removed and the sawn surface gouged or treated with a sharp spoon. If the cartilage is only slightly diseased, it may be sliced off with the knife, and here and there treated with a gouge.

Tendons are now cut short, sinuses laid open or thoroughly scraped out, and the vessels secured. Free oozing is often present in chronic pulpy cases, or where the periosteum has been left in the heel-flap. It is best treated by firm pressure with dry dressings, and elevation of the stump. Drainage being provided, the sutures are inserted; where many sinuses have been present along * the line of the incision, it is no good uniting the wound too closely.

FIG. 213.



Roux's amputation at the ankle-joint by an internal flap. Below is shown a foot upon which the operation has been performed. (Smith and Walsham.)

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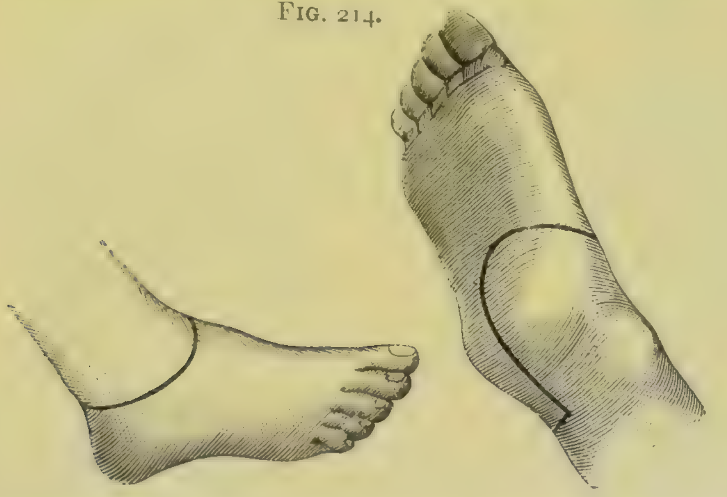
* Sinuses which have been scraped out will give good drainage if enlarged. If any puncture has been made in the heel-flap, it should be utilized for the same purpose. Where a diseased foot has been long on a back-splint, the skin over the tendo-Achillis may be so thinned that it is advisable to make a counter-puncture here and insert a tube.

Roux's Modification of Syme's Amputation (Figs. 213, 214).—In cases where a satisfactory heel-flap cannot be obtained, an efficient substitute can be got by a large internal flap.

The incision is commenced at the apex of the outer malleolus, and carried half across the front of the ankle-joint, from whence it should run inwards in an oblique direction over the astragalo-scaphoid joint, then pass, in a curved manner, downwards and backwards to the middle line of the sole of the foot, and, running along the under surface of the heel, ascend the posterior aspect of that part, and terminate at the outer malleolus, where it commenced. The ankle-joint should be opened at its upper and outer part, the calcis dissected from its connections, the malleoli and a slice from the articular surface of the tibia removed, and the operation will be complete. The shape of the flap will be gathered from the appearance of a foot operated upon (Fig. 213).

FIG. 214.



Roux's amputation. The incisions shown from the outer and the inner side. (Stimson).

Causes of Failure after Syme's Amputation.—(1) Sloughing of the heel-flap. This is nearly always due to faulty operating, to scoring or "button-holing" the flap, or to dividing the posterior tibial high up.* (2) Persistence of sinuses and pulpy disease. If, in spite of repeated scraping out (Fig. 215) with the aid of anæsthetics, this condition recurs inveterately and spreads along the sheaths, the limb must be amputated higher up. This will, however, be rarely called for with perseverance on the part of the patient and surgeon, and a determination on the part of the latter to treat this condition as a kind of malignant disease. If one or two sinuses remain, and look likely to persist, scraping out should be resorted to at once. (3) Recurrence of caries in the tibia. (4) Death of the tendo-Achillis. This rare sequela occurred to me in 1890. The patient was an aged inmate of the Camberwell Infirmary. A bluish undermined patch being laid open on the back of the ankle some weeks after the amputation, the tendon was found to have died up to its junction with the calf muscles. After its removal the parts healed soundly.

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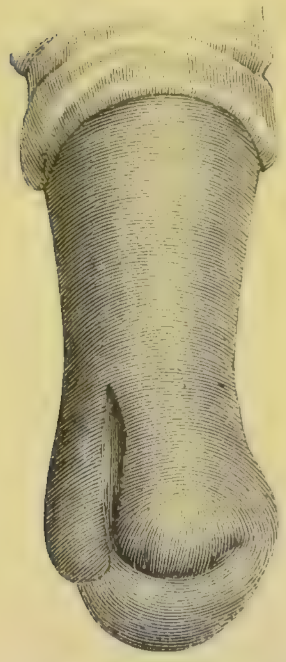
* If possible, the cut ends of the two plantar arteries should always be seen, and not the single mouth of the posterior tibial. In the former case the surgeon is certain that the main vessel is divided below the internal calcanean branch.

FIG. 215.



A Syme's stump soundly healed after scraping out of sinuses had been resorted to. The patient was sent to me by Dr. Fraser, of Romford, and had active secondary syphilis as well as extensive caries of the tarsus.

PIROGOFF'S AMPUTATION
(Figs. 216, 217, 218, 219).

An amputation at the ankle-joint, in which the posterior part of the os calcis is retained and united to the sawn surface of the tibia.

Question of the Value of this Operation especially as compared with Syme's Amputation.—*Disadvantages:* These have been put prominently forward by Scotch surgeons. 1. The amputation is not suited for cases of disease, except of distinctly traumatic origin in young healthy subjects. 2. Occasionally the sawn os calcis fails to unite, causing either a kind of movable joint or necrosis. 3. It is said by some that the stump is more difficult to fit with an artificial foot.* The first two objections are undoubted, but I think that they are quite outweighed by the *Advantages:* 1. No dissection of the heel-flap is needed. 2. The blood-supply is less interfered with. 3. The stump is firmer and more solid. 4. The stump is longer by 1 or 1½ inch, often more.† 5. The stump does not go on wasting, as is the case after a Syme's amputation.‡ 6. Dr. Hewson (*Amer. Journ. Med. Sci.*,

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* Prof. Macleod thinks that the presence of the heel is here "a great drawback, and that the back of the heel, not the firm plantar pad, is what comes in contact with the ground."

† Dr. Hewson (*loc. infra cit.*) gives the shortening after a Pirogoff as from 1 to 2 inches; that after a Syme as 2½ to 3 inches.

‡ The continuance of this wasting is shown by the hospital patient being for some time obliged to stuff the socket of his elephant-boot with a sock. It is not intended by this to depreciate the value of a Syme's stump. Every surgeon knows

1864, pp. 121, 129) has pointed out that, in a Pirogoff, the origin and insertion of the gastrocnemius being both intact, the combined movements of the knee and ankle are preserved, as in running, &c.

Operation.—The position of the patient's foot and the surgeon being as at p. 1134, an incision is made, straight across the sole, from the tip of the external malleolus to a point ½ inch below the internal one.* This incision goes right down to the bone. Its horns are then joined by a transverse cut across the front of the ankle. The lateral ligaments are now severed, care being taken to cut inside the malleoli and to divide the posterior tibial artery as long as possible—*i.e.*, below its origin into the two plantar—and not to prick it after it is divided. With a few touches of the knife at either side of the astragalus, aided by twisting of the foot from side to side and forcible bending of it downwards, the non-articular part of the upper surface of the os calcis comes into view (Fig. 216). A groove is now cut through the fatty tissue and the periosteum, and the saw applied just in front of the tendo-Achillis, obliquely downwards and forwards, care being taken to bring it out through the incision in the heel. The foot being removed, the soft parts around the bones of the leg are carefully cleared to a level just above the tibial articular surface and the malleoli. The saw is next applied in the reverse direction

FIG. 216.

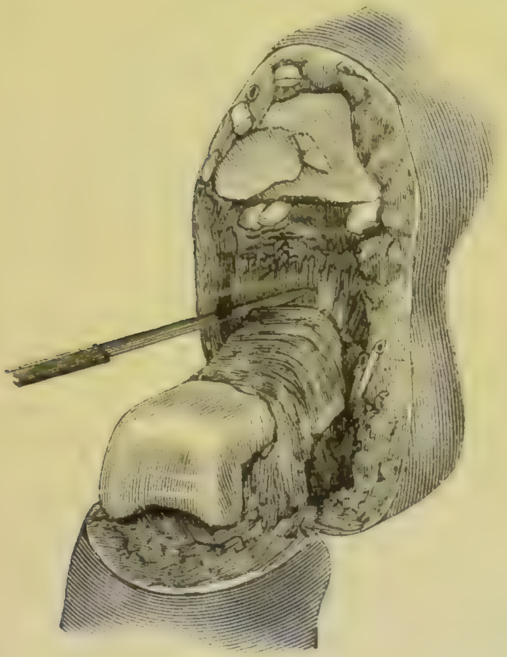
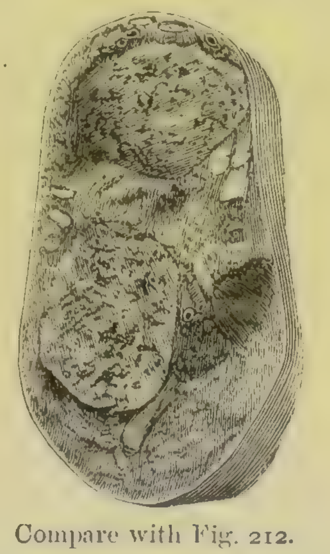


FIG. 217.



Compare with Fig. 212.

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how much good, life-long work the heel-flap is capable of, however much it shrinks, so long as it has healed.

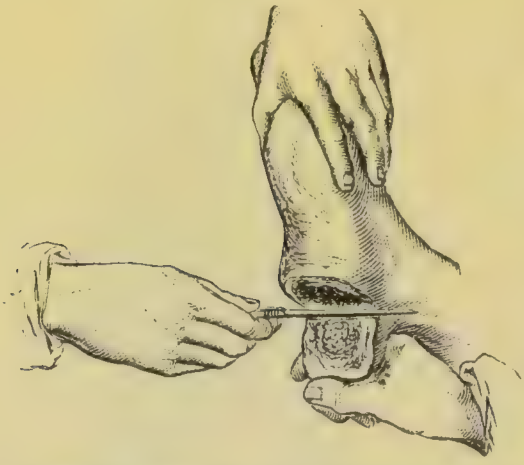
* *I.e.*, not pointing backwards.

to that just given—viz., from below upwards and backwards, and slightly obliquely.

The vessels, the tibials, anterior peronæal, and perhaps one or both malleolar having been secured, the tendons cut square, the bony surfaces are placed in contact, and, if needful, drilled with a clean bradawl and united with wire or stout chromic gut.*

If it is found advisable to convert the Pirogoff into a Syme, all that is needed is to divide the tendo-Achillis and to dissect out the part of the os calcis, keeping the knife close to the bone.

FIG. 218.



Pirogoff's amputation as modified by Dr. E. Watson. (Smith and Walsham.)

Modifications of Pirogoff's Amputation.—One of the chief of these is that introduced by Dr. E. Watson (*Lancet*, 1859. vol. i. p. 577). He claims—(1) That it is shorter and easier, the trouble of disarticulation being avoided. (2) That it is less likely to damage the posterior tibial artery. (3) That it does away with one of the chief difficulties in a Pirogoff's amputation for injury—viz., the want of purchase over the smashed parts while the os calcis is being sawn through.

Operation.—The operator, standing as before, having cut across the sole from the tip of one malleolus to the corresponding point (p. 1134) down to the bone, introduces a small Butcher's saw, or one with a narrow blade, into this wound, and saws off the posterior part of the os calcis by carrying his section upwards and backwards. This and the heel being now retracted by an assistant, the surgeon, resuming his knife, cuts upwards behind the ankle-joint between the sawn bones. The ends of the first incision are now joined by one passing between them, the skin being pulled up a little and the tendons and vessels severed down to the tibia and fibula just above the ankle-joint. Lastly. these bones are sawn through in a slanting manner by directing the saw from before backwards and downwards.† While the bones of the leg are being sawn the heel-flap should be held well up against the back of the leg to keep it out of the way.

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* If the patient is young and healthy, this step is not absolutely needful. I would recommend it in other cases. Thus I have made use of it in a Pirogoff's amputation for inveterate infantile paralysis, with excellent results. If wire be used, it must be left long. A little ether will probably be needed when the wire is removed.

† It will be noticed that the direction of the bone section above given by Mr. Watson is contrary to that usually taught.

SUB-ASTRAGALOID AMPUTATION (Figs. 219–221).

This operation consists, the soft parts being divided as at Fig. 219 or 220, in opening the astragalo-scaphoid joint from the dorsum, and the astragalo-calcanean, of which the interosseous ligament can only be divided by introducing the knife-point from the outer side. The whole foot is then removed in one mass with the exception of the astragalus, which is left mortised in between the tibia and fibula. When the stump is healed, this bone should rest upon the ground by its inferior surface. If, however, the stump should be pulled up by the tendo-Achillis and other cut muscles taking on a firm attachment, it will be the head of the astragalus alone which will rest upon the ground and transmit the weight of the body. While this has the advantage of diminishing the shortening of the limb, it has the grave inconvenience of narrowing the basis of support, and of bringing the weight of the body upon that part of the stump where the cicatrix is necessarily found.

This amputation, very rarely practised in England, has, with that of M. Tripier (p. 1157), largely replaced that of Chopart in France. The following account is taken from Dr. Stimson :*—

"The guides to this operation are the tip of the external malleolus and the head of the astragalus. The joint must be entered from in front on the fibular side, and the strong interosseous ligament which forms the key to the articulation must be divided, step by step, from before backwards and inwards. The posterior tibial vessels must be carefully avoided.

"Beginning at the outer side of the heel nearly 1 inch below the tip of the external malleolus, an incision extending through to the bone is carried straight forward to the base of the fifth metatarsal bone, thence curving forwards across the dorsum of the foot to the base of the first metatarsal, thence obliquely backwards and outwards across the sole of the foot and around its outer border, rejoining the first horizontal part of the incision at the calcaneo-cuboid joint. The soft parts must be separated from the outer surface of the calcaneum and cuboid with division of the peronæal tendons, the dorsal flap dissected back to the head of the astragalus, and on the inner side beyond the tubercle of the scaphoid, thus dividing the tendon of the tibialis anticus and the anterior portion of the internal lateral ligament. The interosseous ligament can then be easily reached by depressing the toes, passing the knife between the astragalus and scaphoid, and cutting backwards and inwards along the under surface of the former. The soft parts on the inner side are then separated from the calcaneum, injury to the vessels being avoided by keeping close to the bone between it and the tendons of the flexor communis, the foot depressed, and the tendo-Achillis divided. This last is a very difficult part of the operation, and great care must be taken to keep the edge of the knife close to the bone so as not to cut through the skin. The posterior tibial nerve should be dissected out and cut off as high as possible, so that it shall not be pressed upon in the stump."

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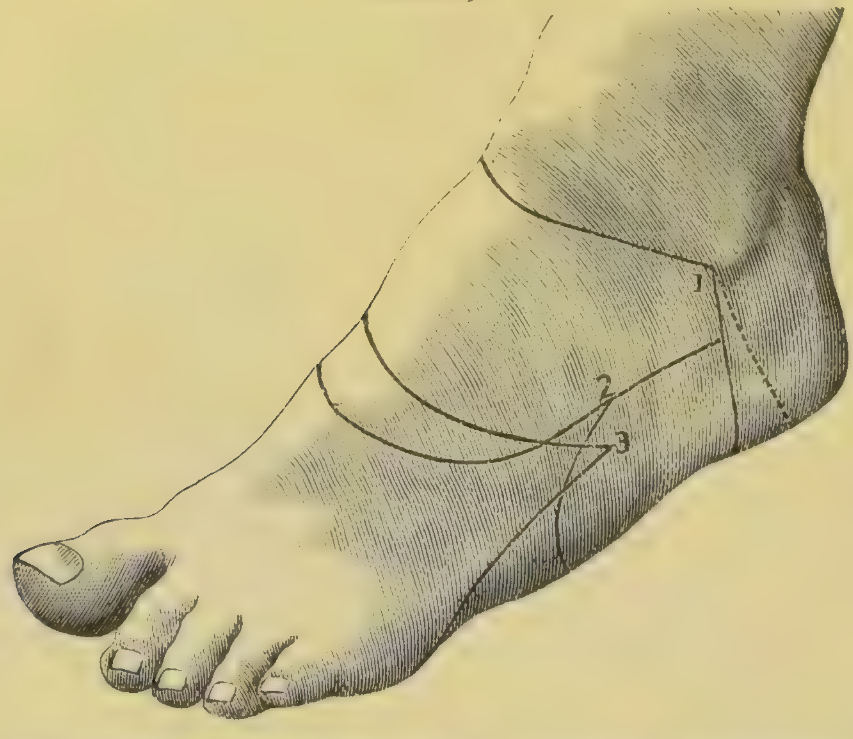
* *Man. of Oper. Surg.*, p. 113.

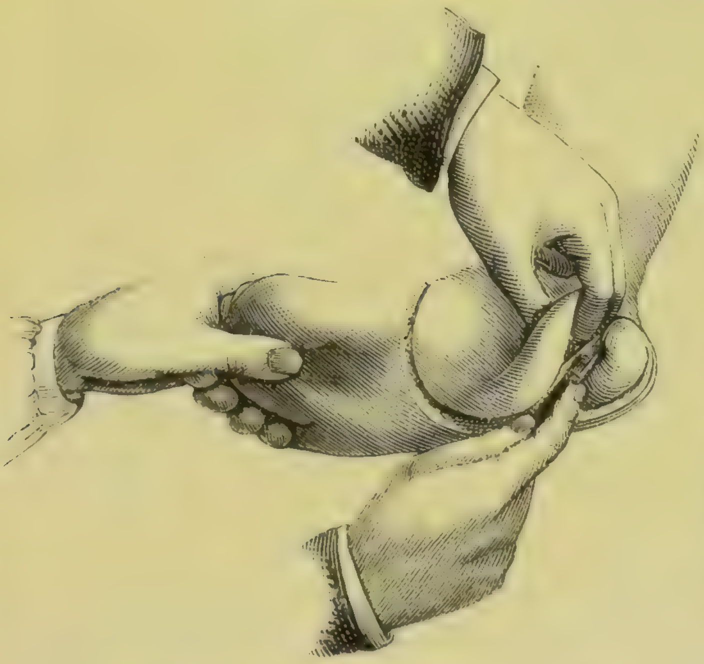
FIG. 219.



1. The incisions in Pirogoff's amputation. The dotted line shows the direction of the plantar incision in that of Syme. 2. The incisions in sub-astragaloid; and 3. Those in Chopart's amputation.

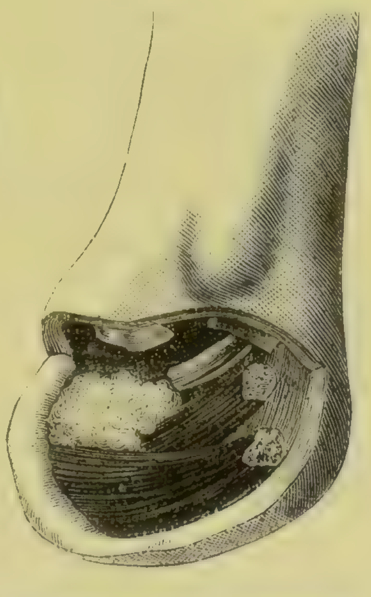
M. Farabeuf advises an internal and plantar flap, whose nutrition is guaranteed by a very large base. This is the flap of Roux (Figs. 213, 220), made considerably longer in front. The incision passes parallel to the outer border of the foot, a full finger's-breadth below the external malleolus, as far as the tuberosity of the fifth metatarsal, then across to the scapho-cuneiform articulation, and the extensor proprius pollicis tendon. Then it descends over the middle of the inner border of the foot, as far as the centre of the sole. Here it begins to turn back along the outer border of the foot, as far as the posterior extremity of the os calcis, where it joins the starting-point. Fig. 220 shows the dissection of this flap in the case of the right foot: the left hand of the operator raises and protects the soft parts in front of the knife, which is kept parallel to the vessels and tendons lying under the sustentaculum tali. Fig. 221 shows the flap before it is sutured.

FIG. 220.



Sub-astragaloid amputation (right foot) by large internal and plantar flap. (Farabeuf.)

FIG. 221.



Sub-astragaloid amputation (left foot) by large internal and plantar flap. (Farabeuf.)

EXCISION OF THE ANKLE.

This operation is one of very disputed value, and thus rarely performed. *Objections:* (1) Disease here is often associated with disease of the tarsus. (2) Even if the wound heals, the foot left is often of little use. (3) Syme's amputation affords not only a radical cure, but a most excellent stump. This may be imperilled by a previous excision of the joint.

Indications.—These, which are very few, must be considered separately, according as they fall under the heading of A. *Disease.* B. *Injury.*

A. *Disease.*—(1) The patient must be young and healthy, with no evidence of other strumous disease, or of phthisis or syphilis. (2) The disease should be of traumatic origin—*e.g.*, following a sprain—and (3) limited to the bones which form the joint, the whole astragalus being taken away if needful. To another class of cases in which this operation has been too often performed—viz., where the patient's health is reduced by discharge, pain, hospital air, &c., where other tarsal bones are involved—this excision is not applicable; it is here much severer than amputation, and leaves the patient most liable to recurrence.* Quite a separate instance of excision in disease may be occasionally practised in advanced cases of infantile paralysis. Here the ankle may be excised (by a transverse incision) some time after the knee has been submitted to the same operation, in order to give a firm basis of support in good position, instead of a flail-like limb which shuts up at the knee and ankle.

The chief points in excision of the ankle-joint which have been raised as objections to the operation are: (1) The difficulty of free exposure of the parts to be dealt with; (2) The frequency with which other bones are diseased. Thus, Mr. F. Jordan † strongly objected to the operation on the ground that the astragalus is not a long bone with an epiphysis in which the chief disease may lie, but a short bone consisting of a mass of cancellous tissue throughout which the disease is more or less diffused. This objection may be answered by the fact that if the disease in the astragalus is found not to be limited to the upper articular surface, it will in no way interfere with the results if the whole bone is removed.‡ And this fact will meet another objection to excision of the astragalus made by Prof. Syme—viz., that the frequency with which disease of the astragalus originates on the under surface of this bone (*i.e.*, between it and the os calcis*) calls rather for amputation than excision. (3) The difficulties of securing afterwards a splint which will combine the three following essentials —viz., (*a*) Sufficient rest; (*b*) Sufficient exposure for needful change of dressings; (*c*) The possibility of antiseptic treatment. Two excellent but too little known splints are Esmarch's bracket-splint, and the iron splint moulded to the back and front of the leg, and front and sole of foot, and covered with india-rubber, introduced by Mr. Paul of Liverpool. This is a model of combined usefulness and simplicity. Both are secured in place with plaster-of-Paris. But if, in addition to much of a cavity to fill up, any tendency to œdema remains, a back and two side splints—all three being interrupted—are, in my opinion, preferable.

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* In Mr. Holmes' words (*Syst. of Surg.*, vol. iii. p. 766), in the first class of case "the inflammatory softening or suppuration does not usually extend far from the neighbourhood of the joint originally implicated, and, after the removal of the diseased bone, the parts take on a healthy action and become rapidly consolidated. In strumous disease, on the other hand, inflammatory softening, if not diffused suppuration, often exists in the tarsal bones or bones of the leg in parts not exposed to view in the operation; and, in patients labouring under general constitutional affections, the parts operated on, instead of consolidating, usually soften, and after a long and exhaustive suppuration the bones are found carious, leaving no resource except amputation, and that sometimes under unfavourable circumstances."

† *Lancet*, 1867, vol. i. p. 729.

‡ Mr. Holmes, whose experience of this operation is a large one, advises *Brit. Med. Journ.*, 1878, vol. ii. p. 875) that the whole of the astragalus should always be removed, for these reasons—(1) As it is often softened to a considerable depth, mere removal of its articular surface will often leave disease behind; (2) in patients low in health, or of strumous constitution, the violence done by the saw may prove the starting-point of renewed caries; (3) the bones of the leg unite quite as firmly to the exposed cartilaginous surfaces of the os calcis and scaphoid as they do to the sawn surface of the astragalus; (4) the shortening is not appreciably increased; (5) the difficulty of the operation is lessened (p. 1146).

B. *Injury.*—In a young, healthy patient, where the vessels and nerves are mainly intact, where the mischief is limited to the ends of the bones, an attempt to save the limb by excision, partial or complete, is abundantly justified. The steps given at p. 1129 for the antiseptic treatment of compound fractures should be carefully attended to, as to the preservation of periosteum, the due providing of drainage, &c. As to gunshot injuries, Dr. Otis (*Med. and Surg. Hist. of the War of the Rebellion*, pt. iii. p. 610) thought that "the substitution of excision of the ankle-joint for amputation effected no saving of life," formal excisions being rarely successful.

Operation.—This may be either by two lateral incisions, or by a transverse one, dividing the extensor tendons, which are sutured afterwards.

Excision by Lateral Incisions. — An Esmarch's bandage being applied above, and the parts rendered evascular as well, the foot is laid upon its inner side firmly supported on a sand-bag. An incision is made along the lower $2\frac{1}{2}$ inches of the posterior border of the fibula, and then, when it has reached the tip of the malleolus, it is carried downwards and forwards at an angle to within an inch of the base of the fifth metatarsal bone. A slight flap is now sufficiently dissected forwards to expose the bone and to clear the peronæi; these being drawn aside, the bone is divided with a narrow saw or cutting-forceps about 2 inches above the malleolus, and removed after division of the external lateral ligament. This wound is now covered with carbolised lint and the foot turned over, and a similar angular incision made along the lower 2 inches of the inner margin of the tibia, and then forwards and downwards as far as the projection of the internal cuneiform bone.* A flap being dissected slightly inwards, the tendons of the tibialis and flexors are exposed and retracted,† the knife being kept close to the bone so as to avoid the posterior tibial vessels.

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* Instances of extensive removal of the bones of the tarsus are given at pp. 1151, 1152.

The internal lateral ligament is now cut through close to the tibia, and on displacing the foot outwards the tibia and astragalus present in part at the inner wound. A metacarpal saw being next passed from the inner to the outer wound, the lower end of the tibia is sawn off sufficiently high up to secure a healthy section of bone, and no more. The astragalus is next treated similarly,‡ all the articular cartilage being removed. Any soft patches of bone are next gouged, and pulpy material snipped away from the synovial sheaths of the tendons, &c. All sinuses are next scraped out or laid open. The only vessels which will require tying are some branches of the peronæal and the malleolar, none of any importance being divided. Very few, if any, sutures should be used, so as to allow of very free drainage.

Excision by Transverse Incision.—The parts being rendered evascular, an incision is made transversely across the front of the ankle-joint from the tip of one malleolus to the other. The extensor tendons being divided, the anterior and lateral ligaments severed, the end of the tibia is exposed, a way cleared for the saw just above the malleoli, and a slice removed. The upper articular surface of the astragalus is then treated in the same way, the peronæal and flexor tendons being drawn aside while the bones are sawn. Any dead bone is gouged away and pulpy tissue removed, as mentioned above. Hæmorrhage being arrested, several of the divided tendons—*e.g.*, the tibialis anticus, two or three of the extensor tendons—are sutured with chromic gut or carbolized silk.

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* The lower extremities of these incisions need not go down to the bones.

† Unless these tendons are sufficiently freed from their connection with the lower end of the tibial, difficulty will be met in everting the foot sufficiently to bring the tibia out of the wound (Hancock, *Lancet*, 1867, vol. i. p. 731).

‡ If the disease here is at all extensive, this bone should be entirely removed (p. 1144). If a section only of the astragalus is taken, much difficulty will be met in removing the upper articular surface. Thus, unless the saw be directed properly, the astragalo-scaphoid or astragalo-calcanean joints may be opened. To meet the difficulty of fixing the foot the heel should be held in the left hand, and the upper surface of the astragalus is pressed against the cut end of the tibia, while an assistant holds the leg firmly on, and a little over, the edge of the table (Porter, *Brit. Med. Journ.*, 1878, vol. ii. p. 792).

In either of the above operations every care must be taken to preserve the periosteum, especially where this is softened and loosened.

A suitable splint is always a difficulty in these cases. On the whole, a back splint and foot-piece, and two side splints, all being padded with gauze, will be found most suitable for the first ten or fourteen days; the side splints, being secured with straps and buckles, readily admit of removal so as to change the dressings. If all the disease has been taken away, and due drainage provided, the dressings will need changing very infrequently. After the first fortnight, the limb may be put up in one of Esmarch's or Paul's splints, secured with plaster-of-Paris (p. 1145). Another arrangement which answers well with a quiet patient is to put up the limb on its outer side, with the knee flexed, on an outside angular splint interrupted opposite the wound, the splint being duly supported with pillows. If the external wound is left freely open, this method gives good drainage.

EXCISIONS OF BONES AND JOINTS OF THE TARSUS.

Before considering these separately, I would invite attention to the following **practical points**:—

i. Those cases are the least hopeful in which there is no history of injury, in which there is evidence of a strumous constitution, or perhaps of disease dating to an exanthem and coupled with the above constitution; cases in which the patient is wan and sickly with long lasting pain and sleeplessness; cases in which the parts are much swollen, dusky red, and glossy, with sinuses numerous or excavated, giving vent to watery, ill-smelling discharge—all points denoting a disease that is not limited to one joint or to few bones. ii. Mere laying open, and, still more, injection, of sinuses where there is disease of the tarsus is absolutely useless in most cases. iii. When a patient is under care for caries of the foot, his lungs should always be carefully examined before operative treatment is undertaken. iv. When the amount of disease present is being estimated, it must be remembered that patients, especially children, will often use their feet with much freedom, limping, even bearing their weight on their toes with the aid of a crutch, though all the time extensive disease is present. v. That before an operation, the parts should always be rendered absolutely evascular by the use of Esmarch's bandages,* and that thus the limit of the disease should be defined as accurately as possible. vi. Subperiosteal excision is only advisable in the case of single bones where the periosteum is already thickened and loosened, and that in other cases it is not of such great advantage as to justify any considerable prolongation of an operation. vii. Strict antiseptic precautions should be made use of wherever this is possible, because —(*a*) Prolonged suppuration will exhaust a patient, whose powers are already sufficiently handicapped by disease and operation; (*b*) Suppuration will cause destruction of the periosteum, and thus fresh caries and necrosis; (*c*) Interference with inflamed bones may, if sepsis result, easily cause osteo-myelitis and pyæmia. viii. When the question arises between excision and amputation, when the powers of repair have been duly considered, the question of time and the rank of life should also be remembered. Thus, after an extensive excision, six months will probably be required before the foot can be used, but only three months after an amputation. The time in the first case may after all be wasted, a point of much importance when the question of schooling, learning a trade, &c., have to be considered. ix. No use of a foot can be permitted after an operation till firm consolidation is obtained. x. If pulpy mischief persist after an operation, the sharp spoon must be freely used, together with laying open sinuses, snipping away of undermined skin, &c. If all carious bone has been removed, the above steps may be repeated again and again here, as in the knee, with ultimate success.

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* This is disputed by some. I strongly advise it. The free oozing after this method may be met by tying any vessels which are seen in the absolutely dry

EXCISION OF THE ASTRAGALUS.*

Indications.—These will be for A. *Disease*, B. *Injury*. Both are rare.

A. *Disease.*—(1) Caries of the bone, especially when compara-

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wound, and then plugging this with strips of sal-alembroth or iodoform gauze, around a drainage-tube, bandaging firmly over well-applied dressings before the Esmarch's bandage is removed, and giving sufficient morphia in the first twelve hours. This dressing will seldom require removal for several days, when the strips must be thoroughly soaked before removal.

* A good instance of the occasional value of this operation has been given by my old friend George Wright (*Pendlebury Abstracts*, 1884, p. 124). The case was one of severe talipes valgus, due to infantile paralysis of a year's standing. The reaction of the muscles to Faradism was extremely poor. "The deformity clearly depended on a partial sub-astragaloid dislocation." The bone was removed by an incision along the inner border of the tibialis anticus, and a shorter one meeting this between the tibialis anticus and posticus. No tendons were cut; one small vessel required twisting. The foot could be inverted into good position after removal of the bone. Twelve months later the child could walk painlessly and much more freely, without eversion, and with a good arch.

tively recent and of traumatic origin in a young and healthy patient, and when the disease is found to be limited to the upper surface. (2) In disease of the astragalo-calcanean joint, where it is thought, from the position of the sinuses, &c., to be more advisable to expose this joint by removing the astragalus than the os calcis. (3) Talipes: excision of the astragalus for these affections has been mainly replaced by removal of wedges of bone (p. 1153).

B. *Injury*.—(1) Primarily. (*a*) In simple dislocation of the astragalus not reducible with the aid of anæsthetics and tenotomy of the tendo-Achillis and the tibials or extensors, if it seem certain that the skin will slough. (*b*) In compound dislocation of the astragalus when the bone is too far displaced or comminuted to admit of replacement, and when the condition of the soft parts, vessels, and tendons does not call for amputation. (2) Secondarily, when the foot is useless and painful. In these cases, especially, strict antiseptic precautions must be taken and free drainage provided.

Operation.—This may be performed by two lateral or a transverse incision, with suture of the tendons. On account of the freer exposure given, I prefer the latter. The parts being rendered evascular, the bone is exposed by an incision crossing the dorsum between the malleoli, as in Syme's amputation; the tendons are cleanly cut, and the astragalus exposed. At this stage all that may be required is to remove a sequestrum from the upper surface of the neck of the bone. The ligaments must be divided by carefully keeping the knife close to the bone* while this is twisted out in the grasp of lion-forceps, aided, if needful, by the levering movements of an elevator.† If the astragalo-calcanean joint is found diseased, this must be now attended to with chisel, gouge, and sharp spoon. The scaphoid is next examined. All pulpy material being removed, hæmorrhage is arrested,‡ the chief tendons sutured, and the centre of the wound closed, the sides being left open for drainage.

EXCISION OF THE OS CALCIS.

Practical Remarks.—Disease here is not infrequent, and often remains limited to this bone for a long time. It may commence in one of three sites—viz., (*a*) the posterior epiphysis, which, not appearing until the tenth year, does not unite till between the fifteenth and nineteenth years; (*b*) the body of the bone; (*c*) the calcaneo-astragaloid joint, either *de novo*, or as an extension of the last. The diagnosis of primary disease in this joint is often difficult; thus the swelling and position of the sinuses recall disease of the ankle-joint. The pain is usually greater than in ordinary disease of the os calcis itself, and the foot is sooner disabled. With an anæsthetic, the ankle-joint is found free, and probes introduced by sinuses may pass towards the level of the upper surface of the os calcis (known by the tubercle for the extensor brevis).

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* Especially at the back and on the inner side.

† Care must be taken in using this not to bruise any soft bone which is used as a fulcrum.

‡ The dorsalis pedis should be secured, and oozing met by plugging the wound with strips of sal-alembroth gauze and iodoform, the ends of the strips being brought out at the sides.

Operation.—The parts being rendered evascular and the foot firmly supported on its inner side at the edge of the table, an incision [*] is made with a strong-backed scalpel, commencing at the inner edge of the tendo-Achillis, and passing along the upper border of the os calcis (*vide supra*) along the outer border of the foot as far as the calcaneo-cuboid joint, which lies midway between the outer malleolus and the fifth metatarsal bone. This incision should go down at once upon the bone, so that the tendon should be felt to snap as the incision is commenced. Another incision is then to be drawn vertically across the sole, commencing near the anterior end of the first and terminating just short of the inner surface of the os calcis, beyond which it should not extend for fear of wounding the posterior tibial vessels. The bone being now exposed by throwing back the flap, the calcaneo-cuboid joint is first found and opened. The peronæi must be dissected out [†] and drawn aside with a blunt hook. The astragalo-calcanean joint is next attacked, and the close connection between the bones at this point constitutes the principal difficulty of the operation, unless the joints have been destroyed by disease. This difficulty can best be met by grasping the bone firmly with lion-forceps, and wrenching it backwards and outwards, aided by levering movements of an elevator, and a knife-point kept very close to the bone. Especial care must be taken on the inner side to avoid the vessels. The bone being removed, any vessels which can be seen are secured, a drainage-tube is inserted, and the gap around it plugged with gauze.

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[*] The above incision is taken from Mr. Holmes' article, *Syst. of Surg.*, vol. iii. p. 771.

[†] Mr. Holmes (*loc. supra cit.*) says that he has always divided these without ill effect. Care must be taken in drawing them aside, for, if this is done too vigorously, one may slough, as happened to me in one of my cases.

The question of preserving the periosteum has already been referred to, p. 1148. Some good cases of excisions of tarsal bones are recorded by Mr. Holmes, *Syst. of Surg.*, vol. iii. p. 769 *et seq.*, and *Surg. Treat. of Children's Dis.*, chap. xxvi.

OPERATIONS FOR MORE COMPLETE TARSECTOMY.

It is scarcely worth while to give directions for the removal of other single bones—*e.g.*, the scaphoid and cuboid—as these are rarely diseased alone, and, if this should be so, their removal is easy.

The operations of Mickulicz and of Dr. P. H. Watson will be described to meet those cases where more extensive disease is present, and where the patient's age and condition justify a trial of these severe operations instead of amputation.

Operation of Mickulicz.*—The object of this operation is to procure an artificial pes equinus, and to preserve the toes and metatarsals, these being brought into a straight line with the leg and the toes bent at a right angle, so that the patient walks on the ends of the metatarsal bones covered by the thick pads of tissue which invest them ; a broader surface of support is provided than after Syme's or Pirogoff's amputations, and there is some elasticity of the foot left. It is especially indicated in cases where the bones of the heel and the soft parts covering them are extensively diseased.

Sir W. Mac Cormac's patient was aged fifteen, and the disease dated to a sprain of the ankle. On the lad's admission the swelling and sinuses pointed to disease of the os calcis ; later on, the ankle-joint became involved. Amputation being refused, Sir W. Mac Cormac operated thus :—"The patient was placed in the prone position. If it be the right foot, the knife is introduced on the inner border of the foot, just in front of the scaphoid tubercle, and a transverse incision, extending to the bone, is made across the sole to a point a little behind the tuberosity of the fifth metatarsal. On the left foot the direction of this incision will be reversed. From the inner and outer extremities of the wound incisions are prolonged upwards and backwards over the corresponding malleolus, and their extremities united by a transverse cut across the back of the leg, down to the bone, at the level at which it is to be sawn, usually immediately above the joint surface of the tibia. In cases where a larger removal of the tibia and fibula is required, the lateral incisions must be more oblique, and the posterior transverse cut made at a higher level. The ankle-joint is now opened from behind, the disarticulation completed, and, after flexing the foot, the soft parts are carefully separated in front until the medio-tarsal joint is reached, through which disarticulation is effected as in Chopart's amputation. The heel portion of the foot, consisting of the astragalus, calcis, and the soft parts covering them, is thus removed. The articular surfaces of the tibia and fibula, with the malleoli, are now sawn off, as well as those of the cuboid and scaphoid. The anterior portion of the foot remains connected with a bridge of soft parts. The blood-supply appears to be ample, for almost directly after the operation blood issued freely from the distal ends of the divided plantar arteries. All hæmorrhage having been arrested, the foot was brought into a straight line with the leg, and the cut surfaces of the bone were sutured together with kangaroo tendon. The attempt to discover and unite the divided ends of the posterior tibial nerve failed, on account of the sodden condition of the soft parts. Suitable dressings and a plaster-of-Paris splint were applied, the toes being brought into a position of complete dorsal flexion."

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* The account of this is taken from a paper of Sir W. Mac Cormac (*Lancet*, May 5, 1888), four figures accompanying this. Mickulicz's paper will be found in Langenbeck's *Arch.*, 1881, Bd. xxvi. S. 191.

The boy made an excellent recovery. Firm bony union took place. In about a month sensibility began to return in the sole, and gradually became more complete. The toes were mobile.*

Operation of Watson.—This is adapted to cases where the medio-tarsal articulation is involved, the importance of which, from the number of bones and the complicated synovial membrane, is well known (p. 1159). In other words, the disease should be situated between the bases of the metatarsal bones in front and the os calcis and the astragalus behind. The parts being rendered evascular, incisions 3 to 4 inches long are made, on the outer side, from the centre of the os calcis to the middle of the fifth metatarsal bone, and on the inner from the arch of the astragalus to the middle of the first metatarsal. The soft parts are carefully dissected off from the dorsal and plantar aspects of the foot by means of these incisions, the left thumb being kept between the point of the knife and the bones. With a curved probe-pointed bistoury the joints between the astragalus and scaphoid, and os calcis and cuboid, are opened up, and, a saw being passed between the plantar soft parts and the metatarsal bones, these are cut through from below upwards. The diseased bones being removed, the wound is firmly plugged and pressure applied with gauze pads and bandages before the tourniquet is removed. That this operation, though little known, is an excellent one in Dr. Watson's hands is shown by the fact that five out of his six cases did well. It must be remembered that it is an operation in the dark, and one that may involve a good deal of damage to soft parts, owing to the amount of disease which has to be removed by somewhat limited incisions.

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* The patient was shown to the Medical Society more than a year after the operation. "He walked up and down the room, both with and without his boot, with great ease and evident satisfaction to himself. The union is quite solid, and he now attends to his daily work without any inconvenience."

REMOVAL OF TARSAL BONES FOR INVETERATE TALIPES.

The removal of single bones—*e.g.*, the cuboid as performed by Mr. Solly, or the astragalus by Mr. Lund—has now been replaced by the resection of a wedge of bone from the outer side, an operation for which we are indebted to Mr. Davies-Colley and Mr. Davy.

Indications.—Cases which deserve the above epithet of inveterate, in which tenotomy and manipulation have been thoroughly tried; cases in which there is evidently confirmed alteration in the shape of the bones—*e.g.*, in talipes equino-varus —such rigidity that the position of the foot cannot be possibly altered, the astragalus projecting outwards on the dorsum, and the scaphoid so displaced that it almost touches the internal malleolus; where the patient walks on the outer border of his foot, and large bursæ have formed over the cuboid; and where the patient is prevented from earning his livelihood. Finally, the surgeon must feel assured as to his power of conducting the case antiseptically.

Operation.—The parts, being rendered evascular with Esmarch's bandages, are duly cleansed and supported on a sand-bag. A T-shaped incision is then made with the horizontal limb along the outer side of the foot over the os calcis and the cuboid, and the longitudinal one at a right angle to this passing across the dorsum and ending over the scaphoid. The flaps thus marked out are turned aside. With a periosteal elevator the tendons and vessels in the dorsum are now raised so that sufficient room is given for the saw to pass between them and the bones. With a retractor on the outer side the peronæi tendons are held out of the way, due care being taken of their sheaths to avoid the risk of sloughing. With a narrow-bladed saw, a wedge of bone of sufficient size is then removed by two cuts, one above and one below, meeting at the scaphoid. The upper of these will pass through the os calcis to the scaphoid, the lower through the cuboid, through the joint between this and the fifth metatarsal, or through the base of this bone, according to the severity of the case. While these sections are made, a blunt dissector may be pushed under the bones very close to their plantar surfaces, so as to protect the soft parts beneath. The wedge of bone is then removed with a lion-forceps, or by levering it out with an elevator, care being taken not to damage any parts used as a fulcrum. As it is twisted out, a few attachments to the structures in the sole may require division or peeling off. If the position of the foot cannot be rectified, the gap must be widened by removing more bone either with a saw or with a chisel and mallet ; it is especially towards the apex that this must be done.* When the foot can be brought into good position any tendons that have been divided are united with carbolized silk or chromic gut. Any vessels which can be seen are then secured, a drainage-tube is inserted, and the wound partly closed with one or two wire sutures. Dressings of dry gauze are then firmly bandaged on before the Esmarch's bandage is removed. The foot is put up with a back and two side splints, or on an external splint with an interruption, the knee being flexed and the limb resting on its outer side. Mr. Davy has devised a special splint to secure eversion. Morphia should be given freely at first if required. In six or eight weeks the union should be firm.

Great care must be taken during the after-treatment to keep the parts aseptic. Mr. Davy lost one case, two weeks after the operation, from septicæmia (*Brit. Med. Journ.*, 1879, vol. i. p. 221). Cellulitis, œdema, &c., are of very likely occurrence, if, owing to an insufficient wedge being removed, much force has to be employed to correct the inversion. Occasionally complete closure of the wound is delayed by the coming away of a scale of bone ; the ill-vitalized corns and bursal tissues may show some signs of sloughing.†

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* Some contracted tendons may now require division before the inversion can be completely overcome. The tendo-Achillis may be divided now or later.

† In a case of Mr. Bennett's (*Clin. Soc. Trans.*, vol. xv. p. 83) erysipelas attacked the sinus, which was all that remained of the wound, and all the union between the bones, which had been very firm, gave way. The case ultimately did well.

CHOPART'S AMPUTATION (Figs. 222–225).

In this medio-tarsal amputation only the astragalus and the os calcis are retained, disarticulation being effected through the joints between the above bones and the scaphoid and the cuboid.

Value of the Operation.—This has been a good deal disputed. The following objections have been raised to it :—

1. That the tendo-Achillis, no longer counterbalanced by the extensor muscles which have now lost their attachment, draws up the heel, tilting down the scar, which now becomes tender and irritable (Fig. 225).

2. In the normal foot the weight of the body is transmitted through the astragalus to the other bones of the tarsus and metatarsus. When, as in this amputation, these bones have been removed, the weight of the body tends to thrust forward the astragalus, no longer supported by the elastic bones in front, against the scar (Fig. 225), and thus renders this tender and crippling.

The above objections apply to the operation performed for injury or disease, the next to amputation for the latter only.

3. If the operation be made use of in caries, this disease is likely to recur in the two bones left.

In answer to the first two of the above objections it may be said that this tendency to tilting upwards of the heel and downwards of the scar may be met : (*a*) By stitching the anterior tendons—*e.g.*, tibialis anticus, extensor proprius pollicis, and some of the tendons of the extensor communis—into the tissues of the sole-flap with stout carbolized silk or chromic gut, so as to give them a fixed point by which they may counterbalance the tendo-Achillis ;* (*b*) by cutting the plantar flap sufficiently long, and securing firm primary union ; (*c*) by division of the tendo-Achillis. This, however, is only of fugitive value.

The third objection is answered by never performing this operation for caries, unless of distinctly traumatic origin, and in a healthy patient.

Operation (Figs. 222, 223).—An Esmarch's bandage being applied, and the foot supported at a right angle over the edge of the table, the surgeon, standing to the right side of the foot, and so that he can easily face the sole, places (*e.g.*, on the right side) his left index and thumb immediately above the tubercle of the scaphoid and the corresponding point on the outer side—viz., the calcaneo-cuboid joint, which lies midway between the external malleolus and the base of the fifth metatarsal bone. He then joins these points by a slightly curved incision crossing the tarsus, and dividing everything down to the bones. The foot being flexed upwards, a plantar flap is then marked out by an incision running from the outer extremity of the first up the outer side of the little toe, then across the sole, along the roots of the toes, and then down the inner side of the great toe to join

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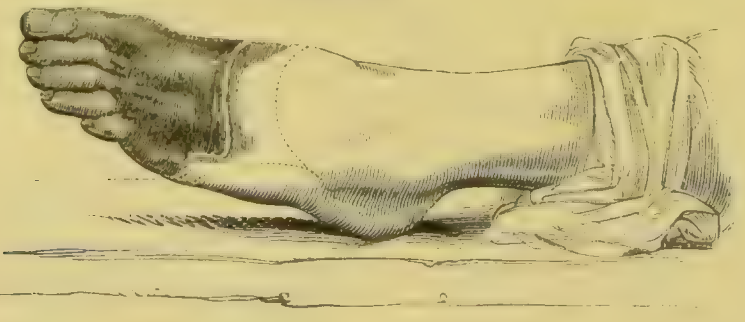
* We owe this ingenious precaution to Mr. Delegarde, of Exeter. Till it is more frequently made use of, and a larger number of cases are collected, the value of this amputation must remain somewhat undecided. In two cases of Chopart's amputation of mine—one a severe crush, and the other for the results of perforating ulcer—in which this precaution was taken, the stumps proved sound and useful.

FIG. 222.



Incisions in Chopart's amputation. (Fergusson.)

FIG. 223.

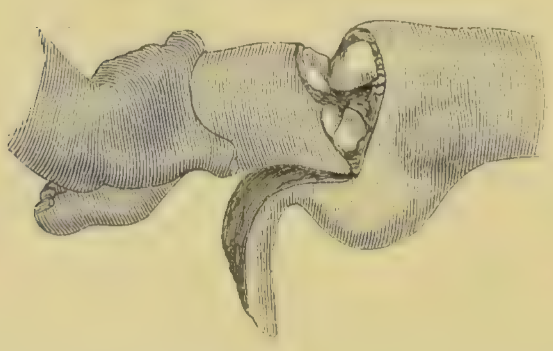
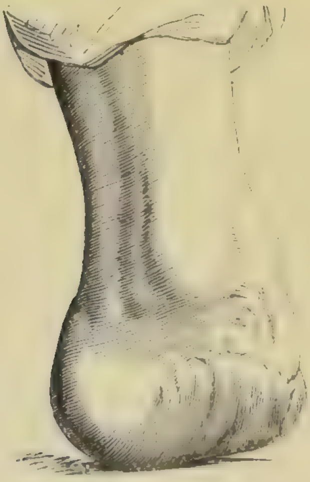
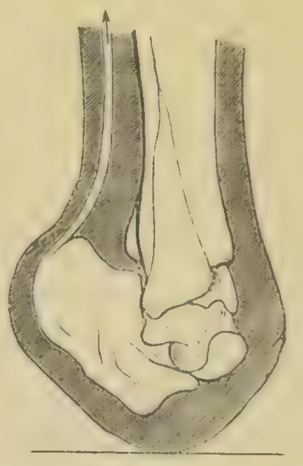


FIG. 224.



Stump after Chopart's amputation. (Fergusson.)

FIG. 225.



Stump often met with after Chopart's amputation, showing its shape, the position of the bones, and the influence of the tendo-Achillis. (Farabeuf.)

the inner extremity of the first. The flap thus marked out is raised with the same precautions given at p. 1160. It is then held out of the way, and the anterior half of the foot being strongly depressed, disarticulation is effected by passing the knife above the tubercle of the scaphoid between this bone and the astragalus, and then between the os calcis and cuboid. In effecting this the position of the joints and the shape of the astragalus must be remembered, and Mr. Skey's words borne in mind: "The joints should be opened with tact and not by force: if the knife be applied to the right surface, it will pass without effort into the articulation; if in the wrong direction, no force will effect it."

The anterior tibial and plantar arteries are then secured, and, on removal of the Esmarch's bandage, any other vessels which require it. The flap is then folded up over the bones, but without any forcible bending, which might interfere with the blood-supply. While it is held in this position, before any sutures are inserted, the extensor tendons (*vide supra*) should be carefully stitched into the fibrous tissues which abound in the heel-flap, care being taken, in so doing, not to puncture the external plantar vessels.

TRIPIER'S AMPUTATION * (Fig. 226).

This operation was proposed by Dr. L. Tripier, of Lyons, as an improved modification of Chopart's amputation, over which it has the following advantages: (1) The horizontal division of the os calcis on a level with the sustentaculum tali gives a large surface of support entirely free from the objections to that in Chopart's amputation (p. 1155). Mr. Wagstaffe (*Lond. Med. Record*, 1880, p. 135) points out further advantges—*e.g.*, that less plantar flap is needed, and that the operator can see the state of the os calcis, amputating higher if this bone be too much diseased. The advantages of M. Tripier's amputation over the sub-astragaloid (p. 1141) are: (i.) The limb is longer, (ii.) the section of the os calcis gives a larger and more solid basis of support. (2) By making the section of the os calcis, the tendons, especially the tendo-Achillis, are better preserved. Plantar and dorsal flaps are marked out by the following elliptical lines, the dorsal starting from the outer part of the tendo-Achillis at its insertion, then passing about 1¼ inch below the external malleolus forwards to a point about the same distance above the tuberosity of the fifth metatarsal bone; the incision then curves inwards to end at the inner side of the extensor proprius pollicis, over the tarsal end of the first metatarsal bone. From this point the plantar flap is marked out by an incision downward and forward over the inner part of the sole, about an inch in front of the base of the first metatarsal bone, and then obliquely across the bases of the metatarsals, and, lastly, backwards so as to join the dorsal incision over the outer part of the os calcis. All the dorsal tendons are then divided along the line of the incision, and the structures in the plantar incision are next cut down to the bones, and a thick plantar flap is then raised until the under surface of the os calcis is exposed, and the point of the heel turned. Disarticulation, as for Chopart's amputation, is then performed. The periosteum covering the under aspect of the os calcis is now incised antero-posteriorly, and detached from the bone up to the level of the sustentaculum tali. The os calcis is next sawn through horizontally from within outwards, on a level with the same process. The projecting angles are then rounded off, and the plantar and dorsalis pedis arteries tied. As in all amputations, the nerve that will be in the flap that will bear pressure—here the posterior tibial—should be trimmed short.

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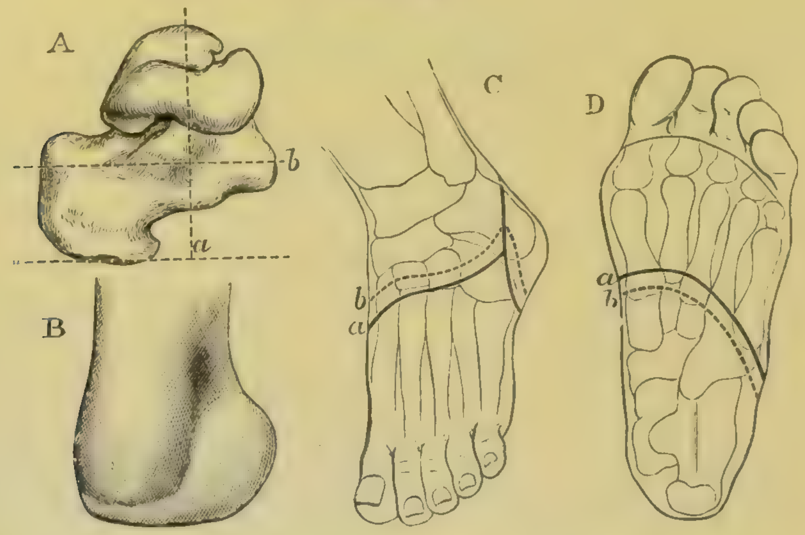
* A case of this amputation by Mr. Hayes, of Dublin, will be found in the *Brit. Med. Journ.*, 1881, vol. i. p. 303.

FIG. 226.



Tripier's amputation. *a*. Section through the skin. *b*. Through the soft parts. (Bryant.)

AMPUTATION THROUGH THE TARSO-METATARSAL JOINTS (Figs. 227–229).

This, though usually spoken of as Hey's or Lisfranc's amputation, includes, accurately speaking, the following **operations**:—

1. **Lisfranc's.**—Amputation by disarticulation through all the joints. 2. **Hey's.**—This is usually described as amputation here by sawing through the bases of the metatarsals. In reality, Hey seems to have disarticulated through the outer four joints, and sawn off the projecting internal cuneiform (*Observations in Surgery*, 3rd edition, p. 552). 3. **Skey's.**—Disarticulation through the outer three and the first joints, the second metatarsal being sawn through (*Oper. Surg.*, p. 406).

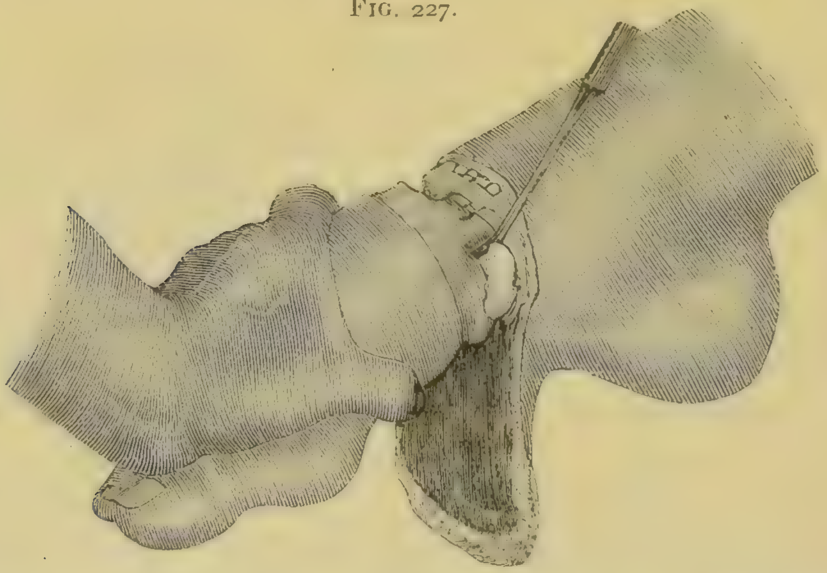
Indications.—Few. (1) Limited crushes in which the sole is sound. (2) Disease limited to the front of the foot. (3) Inveterate bunion, with persistent sinuses and recurrent attacks of cellulitis. (4) Perhaps perforating ulcer. (5) Some cases of frost-bite.

Owing to the complexity of the synovial membrane here, any disease which has invaded the synovial membrane between the second and third metatarsals and the second and third cuneiforms, has also spread to that between the scaphoid and three cuneiforms. This, though of small moment in cases of injury, should put this amputation aside in most cases of disease.

Lisfranc's Amputation (Fig. 227).—The preliminaries are the same as in Chopart's amputation. The surgeon, standing to the right side of either foot, and so as easily to face the sole, places his left index and thumb in the bases of the little and great toe metatarsals respectively. The first of these can always be found by pressure, even if swelling is present; if there be any difficulty with the latter, it will be found a full inch in front of the readily detected tubercle of the scaphoid. These two points thus marked out are joined by a slightly curved incision with its convexity forwards. As a rule, if the tissues in the sole are sound, no dorsal flap should be made, the above incision being kept close to the line of the joints through which disarticulation is to be performed.

The foot being now flexed upwards, the surgeon, looking towards the sole, marks out a plantar flap by an incision running from the outer extremity of the first cut (for the right foot) up the outer side of the foot, then across the heads of the metatarsals, and down the inner side, so as to join the inner extremity of the dorsal incision. This flap should be made a little longer on the inner than on the outer side of the foot, so as to cover the additionally projecting bones on this side. Its cut edge being taken firmly between the finger and thumb, the flap is then dissected up as thickly as possible—*i.e.*, containing all the tissues possible in the sole. In keeping the knife close to the bones some of the metatarso-phalangeal joints will probably be opened. Below these the flap, if steadily pulled upon, will, with light touches of the knife, readily separate from the metatarsal bones. . The flap should be raised evenly, and without scoring or any button-holes. The prominent bases of the first and fifth metatarsals being laid bare, a few strong touches of the point of the knife may be required to separate part of the tibialis anticus and peronæus longus from the base of the former. The anterior part of the foot is now strongly depressed so as so stretch the dorsal ligaments, and the knife, having been thoroughly carried round the base of the fifth metatarsal, is drawn obliquely forwards and inwards so as to open the joints of the outer three metatarsals

FIG. 227.



Disarticulation of the second metatarsal in Lisfranc's amputation. The knife is being used as described below to separate the second from the first metatarsal bone.

with the cuboid and the external cuneiform. The joint between the first metatarsal and the internal cuneiform is next opened, and, lastly, the second metatarsal is next freed as follows:—The knife being held firmly in the fist, its point is inserted between the first two metatarsal bones, and the knife carried backwards and forwards in an antero-posterior direction in the long axis of the foot (Fig. 227). The same is then done between the second and third metatarsals, and, the lateral ligaments being thus divided, the joint between the second metatarsal and the middle cuneiform is then found and opened,* this being facilitated by strongly depressing the foot, care being taken not to do this so violently as to separate the second metatarsal from its upper epiphysis.* A few remaining touches of the knife, aided by a twisting movement, will then suffice to separate the foot.

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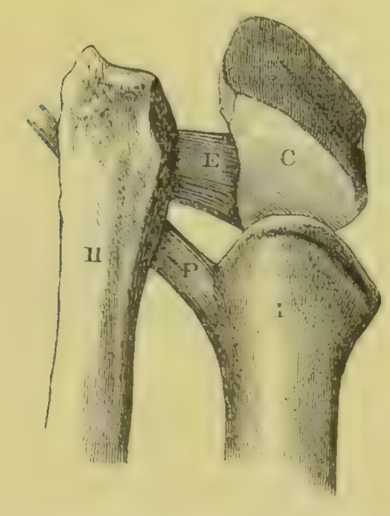
* The position of this joint must be remembered and the way in which the base of the second metatarsal bone is locked in between its fellows and the cuneiform bones. Its base projects upwards between ⅓ and ¼ inch above the others.

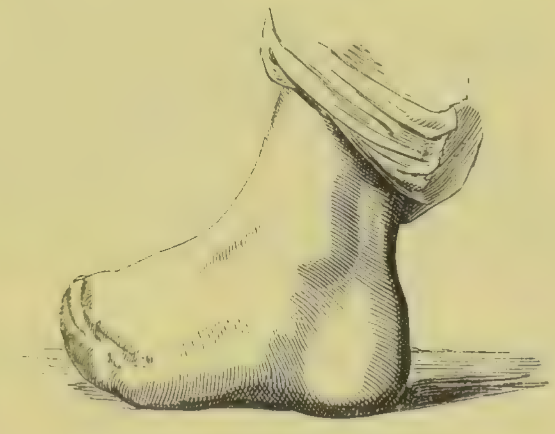
This method of cutting the plantar flap before any attempt is made to disarticulate is strongly recommended in preference to disarticulating immediately after making the dorsal incision by passing the knife behind the bones and cutting the flap from within outwards. In thus disarticulating before making the plantar flap, it is quite possible to puncture the tissues in the sole, and perhaps to wound the external plantar artery. Again, passing the knife behind the metatarsal bones often leads to a hitch, especially with the projecting fifth.

FIG. 228.



C. Internal cuneiform. I. First metatarsal. II. Second metatarsal. E. Internal tarso-metatarsal interosseous ligament, passing between internal cuneiform and adjacent angle of second metatarsal. P. Peronæus longus. (Farabeuf.)

FIG. 229.



Stump after Lisfranc's amputation. (Fergusson.)

The dorsalis pedis and the external plantar artery are now secured, with any smaller vessels which need it. Tendons are cut square, drainage provided, and the plantar flap then brought up and secured in accurate position.

Owing to the thickness of the heel-flap and its tendency at first to unfold itself downwards, numerous points of suture, of sufficiently stout wire or carbolized silk, must be made use of, or one or two hare-lip pins may be employed.

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* While the surgeon is disarticulating the metatarsal bones the plantar flap must be held well out of the way to prevent its being punctured.

AMPUTATION OF THE TOES.

Practical Points.—(1) Any plantar scar is to be avoided. (2) The line of the metatarso-phalangeal joints lies a full inch farther back than the inter-digital folds of the skin * (Holden). (3) Partial amputations (save in the case of the great toe) are very seldom advisable, the stumps left being of little use, and inconvenient owing to their liability to stick upwards.

AMPUTATION THROUGH THE PHALANGES OR THE INTER-PHALANGEAL JOINTS.

These operations are not recommended, for the reasons just given. If a patient insist on having one performed, the directions already given for the fingers (p. 4) will be found sufficient.

AMPUTATION OF ANY OF THE FOUR SMALLER TOES AT THE METATARSO-PHALANGEAL JOINTS.

This amputation is performed much as in the case of the fingers (p. 6), but the following points must be remembered:—

(1) The line of the joint lies a full inch above the web (*vide supra*). (2) The head of the metatarsal bone is not here removed, so as to leave the supporting power of the foot undiminished. (3) It is most important to avoid, as far as possible, any scar in the sole.

The scar, a simple antero-posterior one, is well protected by the adjacent toes. The incision should always be begun on the dorsum, even in the case of the little toe, so as to avoid friction of the boots.

AMPUTATION OF GREAT TOE AT THE INTER-PHALANGEAL JOINT (Fig. 203).

This is usually performed with a plantar flap, as at p. 2.

AMPUTATION OF GREAT TOE AT THE METATARSO-PHALANGEAL JOINT (Fig. 230).

This is performed by the oval method described at p. 6. The following points must be borne in mind:—

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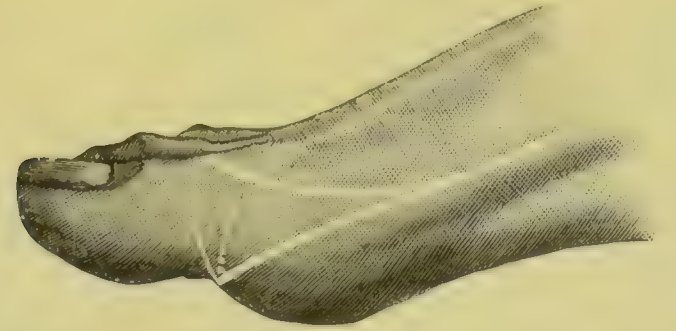
* According to Erichsen, as a general rule it will be found that these articulations are about the same distance above the web as the point of the toes are below it. This, I think, places the line of the joints too high.

(1) Owing to the large size of the head of the metatarsal bone, the flaps are often cut of insufficient length. The incision must be begun 1¼ inch above the joint, and carried well on to the phalanx, one flap being cut longer than the other if needful.

FIG. 230.



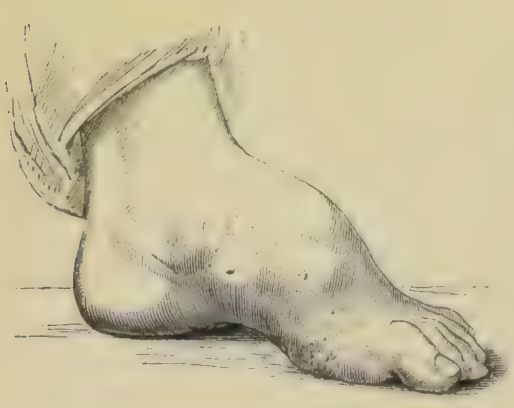
Dorsal and internal flaps for amputation of the great toe and the head of its metatarsal. (Farabeuf.)

(2) The sesamoid bones must be left in connection with the head of the metatarsal bone, as any attempt to dissect them out is likely to imperil the vascularity of the flap, especially after middle life.

In all other details the steps of this amputation are very similar to those already given at p. 6.

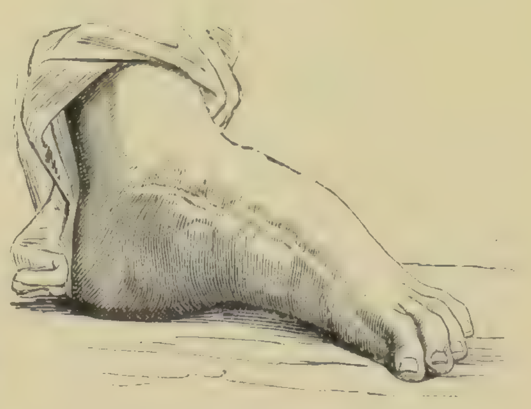
Though it is recommended by some excellent surgeons to remove the head of the metatarsal bone either transversely or obliquely from within outwards, this step, narrowing as it does the treading width of the foot, is not advisable, unless the condition of the skin is such as to render it impossible to obtain sufficient flaps to cover the entire head.

FIG. 231.



Amputation of great toe and its metatarsal bone by internal flaps. (Fergusson.)

FIG. 232.



The foot left by the operation. (Fergusson.)

CHAPTER VII.

OSTEOTOMY.

OSTEOTOMY OF THE FEMUR FOR ANKYLOSIS OF HIP-JOINT—FOR GENU VALGUM.—OSTEOTOMY OF THE TIBIA. — OSTEOTOMY FOR DISPLACEMENT OF THE GREAT TOE IN BUNION.

FOR ANKYLOSIS OF HIP-JOINT.

THIS includes **Adams' operation** of division of the neck of the femur and **Gant's operation** of division of the shaft of the femur just below the trochanters. The latter being much the simpler, and giving excellent results, will, I think, replace the former. These operations are intended to remedy cases in which the hip-joint is permanently flexed and stiff, and the patient accordingly crippled, either from old hip disease, or from ankylosis after rheumatic fever, pyæmia, &c.; cases in which extension has failed, together with trials of straightening the limb with the aid of anæsthetics.

Adams' operation divides the neck of the femur subcutaneously within the capsule. It is best suited for those cases in which the neck remains unabsorbed, as in ankylosis after rheumatic fever, and, much more rarely, pyæmia. A long tenotome or a straight narrow bistoury is entered a little above the great trochanter, and carried straight down to the neck of the femur, dividing the muscles and opening the capsule freely. The knife being withdrawn, the excellent saw which bears Mr. Adams' name is passed along the wound made down to the neck of the bone, which is then sawn through. After sawing for about four or five minutes, the limb should become movable. If this is not the case, the section has been made, not through the neck itself, but through the junction of the neck and shaft.

In order to bring down the limb completely, the contracted tendons of the adductor longus, sartorius, and perhaps the rectus, will probably require division with a tenotome. The operation should be conducted with strict antiseptic precautions.

The limb is straightened at once, and put up with a long outside splint—*e.g.*, a Désault's—and a little morphia given subcutaneously. There is no hæmorrhage, and the wound heals quickly.

This operation gives good results, though, as I have said, I prefer Gant's, owing to its greater simplicity. For there is no doubt that if the bone is dense from previous inflammation, and if the section trenches upon the shaft instead of going through the neck only, the sawing may be very tedious. Thus I have twice seen cases in which this took over half an hour.

A case is mentioned in a report from a committee of the Belgian Academy of Medicine, in which a patient who had been submitted to Adams' operation insisted on getting up on the twentieth day. Hæmorrhage came on from the fragments wounding the femoral vessels or some large branch. The femoral was tied just below Poupart's ligament; the hæmorrhage ceased, but free incisions were required for suppuration. The patient ultimately recovered. The same committee reported a death from hæmorrhage, and one from purulent infiltration. No bad results have, I believe, followed in England.

Gant's Operation.—Here the shaft of the femur is divided just below the trochanters. Thus the operation is a simpler one than that just given, as the shaft is more readily reached and divided than the neck. Furthermore, it is an operation of wider applicability, for it is suited to all cases, not only those in which a neck remains, but those more common cases of ankylosis after hip-disease, in which repair has taken place with partial displacement of the head, or what remains of it. The fact that in these cases there is next to no neck left to divide, makes them unsuited for Mr. Adams' operation.

A long tenotome or, better, a sharp-pointed, narrow, straight bistoury is entered just below the great trochanter, and made to divide everything down to the bone as it is lodged upon the outer aspect of the anterior surface, and then drawn down over the outer surface of the shaft. As it is withdrawn the wound is a little enlarged downwards. The saw is then introduced along the wound well down to the bone, and the outer two thirds of this sawn through, the rest being effected by snapping the bone by lateral movements. The same tendons (p. 1164) will probably require division.

In neither case is it any practical good to try and secure a false joint.

OSTEOTOMY FOR GENU VALGUM (Figs. 233–235).

Under this heading the following operations will be described :—

I. **Division of the Shaft of the Femur from the Outer Side.**

II. **Division of the Lower End of the Femur from the Inner Side, just above the Epiphysial Line** (Macewen).

III. **Division of the Internal Condyle Obliquely** (Ogston).

IV. **Division of the Lower End of the Femur and the Upper End of the Tibia above and below their respective Epiphyses** (Barwell).

I. **Division of the Shaft of the Femur from the Outer Side** (Figs. 233–235).—The limb being supported, with the knee flexed, on a sand-bag, an incision about an inch long is made at a right angle to and down to the bone on its outer side about 3 inches above the external condyle. The knife—a narrow, straight bistoury—should go down to the bone deliberately, and cut firmly and strongly on it, enlarging the wound slightly as it emerges, in order that the soft parts may not be damaged if the heel of the saw is depressed, and that there may be no lip of tissues to hinder the escape of discharges. The saw or chisel is then introduced, and the bone divided for its outer two thirds. As the thicker part of the bone is on the outer side, as soon as this is divided the inner third usually gives way readily on carrying the knee and leg from without inwards. But the operator should continue the division of the bone till he can feel certain that two thirds are divided, for if, after dividing only half, he tries, especially in the case of a dense bone, to fracture the rest and straighten the limb, either great and prolonged force must be made use of, leading probably to irritation, cellulitis, and suppuration, with, perhaps, necrosis, or the saw or chisel must be re-introduced, a point to be always avoided if possible, as the difficulty which is usually met with in hitting off the original track will be likely to lead to the above drawbacks.

The *advantages* of the above method are (1) that the femur is divided at a much narrower part than in the supra-condyloid operation of Macewen, and that thus it is more easily and quickly done. (2) The bone section is farther away from the epiphysis, and the line of the synovial membrane, in case subsequent inflammation takes place. (3) There are no important blood-vessels near (p. 1173).

II. **Division of the Lower End of the Femur from the**

Inner Side, just above the Epiphysial Line (supra-condyloid of Macewen*) (Fig. 235).—The knee being flexed and supported firmly on a sand-bag, the skin cleansed, the position of the adductor tubercle is defined, and a longitudinal incision about an inch long (a little longer than the breadth of the chisel to be used) is made down to the bone at a point where the two following lines meet—viz., one drawn transversely a finger's-breadth above the superior tip of the external condyle, and another drawn longitudinally about ½ inch anterior to the adductor tubercle. The scalpel goes at once down to the bone. Superficial veins may be cut, but no artery normally distributed, as the incision is below and anterior to the anastomotica magna and above the superior internal articular. Before withdrawing the knife, the osteotome‡ is introduced by its side down to the bone in the same way as the knife—*i.e.*, parallel to the long axis of the limb—is then turned

FIG. 233.†

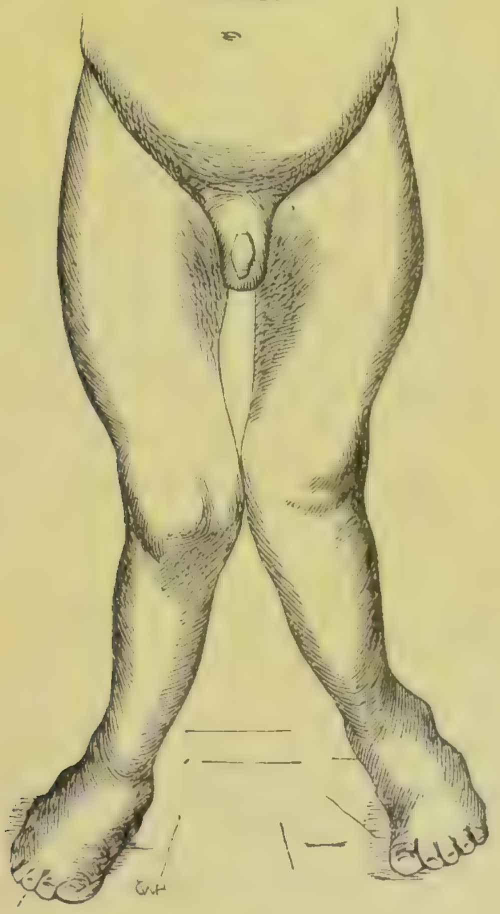
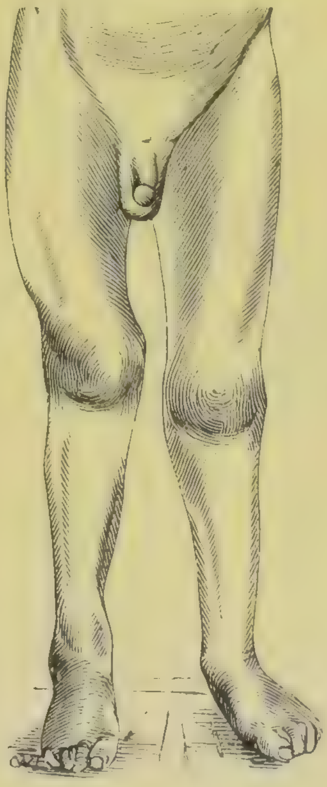


FIG. 234.†



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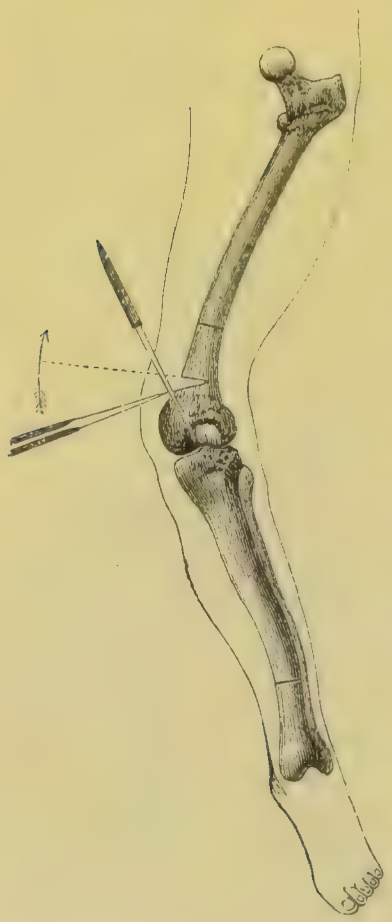
* *Osteotomy*, p. 120.

† Double genu valgum treated by division of the shaft of the femur from the outside. A good average case, both as to its severity and the results of operation. Some flat foot remains on the left side.

‡ In adults a second, or even a third, finer instrument may be used, being slipped in over the first as this is withdrawn. In children one instrument will suffice.

at a right angle to it, and the inner two thirds cut through. *The direction of the bone-incision* is most important. The surgeon must cut transversely across the femur on a level with a line drawn ½ inch above the tip of the external condyle.* Otherwise, as in a valgous limb the whole internal condyle is lowered, a line drawn transversely from the adductor tubercle might land the operator low down in the external condyle. The osteotome must be driven at first from behind forwards and to the outer side; it is then made to move forwards along the inner border until it comes to the anterior surface, when it is directed from before backwards and towards the outer posterior angle of the femur. By keeping on these lines there is no fear of injuring the artery. The hard exterior of the bone usually resists the osteotome, especially in adults, but several strokes cause it to penetrate this superficial dense portion,† when the instrument will pass easily through the cancellous bone. The surgeon will soon

FIG. 235.



The transverse line on the shaft of the femur shows the site of division of the bone from the outer side. Below this are shown Macewen's and Ogston's operations. The arrow indicates the direction in which the osteotome is worked in the former. The line on the tibia shows the site of division of the bone for an ordinary rickety curve. This curve in the lower third should have been shown more marked. (After Barker.)

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* The incision above given will avoid the epiphysis and synovial membrane. The line of the former may be usually represented by one crossing the femur at the level of the highest point of the femoral articulating surface, and running through or just below the adductor tubercle, so that, the incision being an inch above the tubercle, the epiphysis will be cleared. The only part of the synovial membrane which is as high as the bone incision is that under the quadriceps, which may reach in the adult as high as 2 inches above the trochlear surface. It is somewhat triangular in shape, its base being at the condyles, and it generally tapers to the middle line as it ascends. There is generally a quantity of fat between it and the bone. The spot selected by Dr. Macewen for his incision is posterior to this point.

† The osteotomes must be bevelled on both sides; wedge-like, and sufficiently trustworthy for hardness and toughness, points only to be secured by getting them of first-rate and painstaking makers. Dr. Macewen's test is as follows:—If the instrument will neither turn nor chip in penetrating the thigh-bone of an ox, it is well suited for cutting human bones.

recognize by touch or by hearing when the osteotome meets the hard layer on the opposite side. If it be thought desirable to penetrate this outer dense part, it must be done very steadily, so as to check any undue impetus on the part of the osteotome. A sponge, wrung out of 1 in 40 carbolic lotion, is then placed over the wound; the surgeon, grasping this and the limb with his left hand, and taking the limb again lower down with his right, gives the extended limb thus held a quick jerk inwards; this is repeated if needful, or the limb may be carried outwards, and thus broken or bent sufficiently.

III. **Division of the Internal Condyle Obliquely** (Ogston*) (Fig. 235).—This operation, though a great improvement on the operations which preceded it—viz., opening the joint and sawing off the internal condyle—has been, practically, replaced by others—viz., Macewen's, and division of the shaft from the outer side. The free opening of the joint, with its great risks if the wound becomes septic, and the stiffness in any case, have led to this.

The limb, being flexed, and supported on a sand-bag, a long tenotome is entered about an inch above the upper border of the articular surface of the femur exactly in the middle of the inner aspect of the thigh, and with it an incision is made down to the bone, downwards and forwards, until its point is felt beneath the skin in the inter-condyloid notch.† The knife must cut down upon the bone decidedly, and as it is withdrawn it must enlarge the opening for the saw. An Adams' saw is then thrust along the knife track, and the inner condyle sawn off from before backwards. The bone must be sawn almost completely through, the strokes being increasingly careful as the back of the bone is reached. When the section is thought to have nearly reached this point the saw is withdrawn, the wound covered with a carbolized sponge, and the extended leg forced strongly inwards. The condyle now slips up somewhat on the cut surface of the femur.

IV. **Division of Tibia as well as Femur.**—The division of the tibia (and the fibula also) as well as the femur has been advocated by Mr. Barwell. It will only be required, Dr. Macewen thinks, in cases of *very* aggravated genu valgum, for these reasons: (1) As a rule the tibia is only involved to such a slight extent that osteotomy of the femur is alone sufficient to straighten the limb. (2) Even when the tibia is markedly involved the limb can be sufficiently straightened to appear quite symmetrical when clothed. (3) The amount of straightening brought about by division of the tibia is disappointing. The same is the case when the fibula is also divided. Dr. Macewen explains this by the mass of muscle on the outer and back part of the limb, which tends to bind the tibia and make it inflexible. For the above reasons Dr. Macewen has abandoned this operation, trusting to division of the femur alone, combined, if needful, with the division of the biceps.

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* *Edin. Med. Journ.*, March 1877.

† If the patella is sufficiently dislocated outwards, the point of the saw can be felt in the groove; but if the patella is not so displaced, it must be lifted up and the point of the saw passed under it.

Operation.—An incision is made as at p. 1171 over the inner surface of the tibia just below its tubercle, and the bone divided with osteotome or saw from within outwards. The tissue on the anterior part just below the tubercle is much the densest. The section of the tibia should be made on the same occasion as that of the femur. Dr. Macewen has never found it needful to operate on the fibula.

In extremely aggravated cases, multiple osteotomies will be required on the femur and the tibia. Thus in one case of genu varum, in which the limbs (when the ankles were placed together) formed a circle, Dr. Macewen performed ten osteotomies at one time (*loc. supra cit.*, figs. 40 and 41). However an osteotomy wound is made, whether with saw or chisel, no attempt should be made to close it, but a little iodoform dusted on and dry-gauze dressings applied. It is very rarely needful to remove these before the tenth or fourteenth day. If a stain come through, it should be dusted with iodoform and a little fresh dry dressing applied.

Dr. Macewen uses a splint consisting of a long outside, a short back, and a foot-piece.* I have usually preferred plaster-of-Paris, applied by Mr. Croft's method, for children, amongst whom my experience has mainly laid. It makes even, steady pressure upon the muscles around the wound, keeping them and it at rest, and it allows the patient to be more easily moved, especially when both limbs have been operated on. The outer piece of flannel should be brought high up, to the level of the iliac crest, so as to better command the muscles which disturb the upper fragment. Where the child is likely to be restless a long outside splint should be applied. I make use of this in all my cases of osteotomy of the femur. However the limb is put up, the bandages must be applied firmly and evenly, but without undue tightness. The condition of the toes, as to colour and movement, must be carefully watched. When the dressings are removed at the end of ten or fourteen days I like to have an anæsthetic given, and to rectify any slight remaining deformity.

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* Dr. Macewen advises the use of a mattress consisting of four parts, the two centre pieces corresponding to the gluteal region, and easily removed to admit of the introduction of the bed-pan.

The splint in the case of plaster-of-Paris should be continued for six weeks, when the limb may be only supported with sand-bags if the union is firm. Passive and active movement may be now allowed. In about another fortnight the patient may be got up, on crutches, under observation. Before the patient leaves the surgeon's eye, care should be taken that he can bend his knee well.

OSTEOTOMY OF THE TIBIA.

This may be (A) **Simple Division** or (B) **Cuneiform**—*i.e.*, **the taking out of a wedge of bone.** The former of these, a very simple operation, will suffice for the ordinarily curved tibiæ, where the bone is bent laterally and the bend is most marked at the junction of the middle and lower thirds. Cuneiform osteotomy will be required when the bending is not only lateral, but antero-posterior as well.

A. **Simple Osteotomy of the Tibia** (Fig. 235).—The parts being cleansed and the limb resting on its outer side on a firm sand-bag, the surgeon notes, at the anterior and inner margins of the tibia, the spot where the curve is sharpest. Fixing his left index over the inner margin, he enters a long tenotome or narrow bistoury exactly over the crest of the tibia, sends it down under the skin over the inner surface of the bone till its point is felt just beneath the finger; it is here pushed through the skin to make a counter-puncture for drainage. The knife, hitherto held horizontally, is now turned vertically and cuts firmly on the bone, dividing the periosteum, thick in these cases, in one line right across the inner surface of the tibia. As the knife is withdrawn it is made to enlarge the wound of entrance slightly, to make room for the saw. This (Adams') is now introduced in the same way as the knife, carried horizontally down to, but not through, the puncture through the skin of the inner border of the tibia. The left index keeping guard at this spot, the saw is turned towards the bone and cuts through the inner two thirds of it. The entrance of the saw into cancellous tissue can be known by the diminution of resistance and the increased bleeding which often occur, but the best test of the depth to which the operator has arrived is the depth of the groove in which the saw has sunk. When the bone is sawn sufficiently, carbolized lint is placed on the wound, and the surgeon, firmly placing his two hands, close together, immediately above and below the wound, sharply carries the lower fragment outwards. If the saw has been sufficiently used, the tibia snaps distinctly, while the fibula* yields with a "greenstick" sensation. Great care must be taken to exert the force just on the sawn portion, or the ligaments of the ankle or the superior tibio-fibular joint may be strained and damaged. Attention has already been drawn to the need of using the saw sufficiently, otherwise the parts will be bruised and damaged in the futile attempts at fracture. A little iodoform should be dusted on, and the usual dry-gauze dressings applied.

B. **Cuneiform Division of the Tibia—Removal of a Wedge.**—The parts being duly cleansed, an incision is made along the crest of the tibia equal to the base of the wedge which is going to be removed. It need not be longer, as the skin can be pulled up and down if needful. The periosteum is then divided cleanly, and separated from the tibia with the handle of the scalpel carbolized. This membrane being held out of the way with retractors, a wedge is next removed with an osteotome or a narrow and sharp chisel but little bevelled. The gap can then be enlarged by removing from either side further shavings as required. Occasionally free hæmorrhage takes place from the medullary artery, but this soon stops with firm sponge pressure. The limb is now straightened by bending the lower fragment upwards† so as to bring the surfaces of the gap in contact. The periosteum at the upper and lower angles of the wound may be closed with chromic catgut sutures cut short. The skin wound is also closed above and below, but left open in the centre for drainage. Sufficiently thick dressings should be applied to meet any oozing from the bone.

OSTEOTOMY FOR DISPLACEMENT OF GREAT TOE IN BUNION.

Mr. Barker, at the suggestion of a University College student, has recommended this mode of correcting the inward deformity when very troublesome in these cases. Antiseptic osteotomy of the first phalanx will be found simpler, and thus preferable, to division of the shortened external lateral ligament, and any tendons, such as the extensor longus digitorum, which require it. In bringing the line of the great toe straight after osteotomy, care must be taken not to do this too rapidly, or the contracted skin on the outer side of the toe may give way.

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* In many of my earlier cases I cut down upon and divided this bone, a step not at all needful.

† Aided by movements in the opposite direction, and from side to side if needed. The fibula is broken subcutaneously.

Causes of Death and Failure after Osteotomy.

1. Septic troubles.—Such a case will be found published in the *Clin. Soc. Trans.*, vol. xii. p. 27. It is too probable that other operators have not been so candid. 2. Carboluria.—A case of rapidly fatal carbolic intoxication after antiseptic osteotomy of the tibia will be found in the same *Transactions*, vol. xiv. p. 201. 3. Hæmorrhage.—At least one case has occurred of hæmorrhage from the femoral and one from the anastomotica after division of the femur. I have also heard of one in which the posterior tibial was injured in osteotomy of the tibia. 4. Necrosis.—This occurred in one of my cases of osteotomy of the femur, a lad of sixteen. It was noticed that he took the anæsthetic (ether) very badly, and when the effects of this had passed off he was extremely restless and excited for forty minutes. To this I attribute the mischief that followed. Suppuration with a very unhealthy state of the wound, œdema, and cellulitis ensued, leading to necrosis. Eventually the lad recovered, but required a cork sole of 2 inches. The presence of a presystolic murmur perhaps accounted for the effects of the anæsthetic. 5. Division of the tibialis anticus tendon. —This occurred in an osteotomy of the tibia performed by one of my dressers, who forgot how close the tendon lies to the outer side of the crest. The cut ends were joined by chromic catgut, and the action of the muscle was unimpaired.

CHAPTER VIII.

TENOTOMY.

TENOTOMY OF THE TENDONS ABOUT THE FOOT.—SYNDESMOTOMY.—TENOTOMY OF HAMSTRING TENDONS.—TENOTOMY OF STERNO-MASTOID.

TENOTOMY OF TENDONS ABOUT THE FOOT.

Division of Tibial Tendons.

Tibialis Anticus.—This is usually divided where it is crossing the ankle-joint from without inwards, a little above its insertion into the internal cuneiform. It has, here, the anterior tibial vessels on its outer side, but separated from it by the extensor proprius pollicis.

The surgeon usually stands on the opposite side of the leg to that of the tendon, either facing the trunk or with his back towards it, as is most convenient. The assistant stands opposite to him, grasping the foot with one hand and the leg with the other. The position of the tendon is made out by making it tense by abducting and extending the foot. The surgeon then notes the position of the anterior tibial vessels, defines exactly the width of the tendon, and places the tip of his index finger exactly on the side of the tendon farthest from him. He then inserts the tenotomy knife vertically close to the tendon on the side nearest to him; sinks it lightly till he feels sure it is on a level lower than that of the tendon; then sends it horizontally across till he feels its point just under his index finger, and, having turned its edge upwards, finally, by a series of light levering or sawing movements, cuts through the tendon. The assistant relaxes the foot—*i.e.*, adducts and bends it upwards—when the knife is first introduced, but places it on the stretch at a signal from the surgeon. Finally, as soon as the completion of the creaking sound and the sudden snap denote the division of the tendon, the foot is again relaxed. A small pad of gauze being at once applied, the foot is put up in the everted position. For this purpose nothing is, to my mind, so simple and efficient as a well-padded splint of the proper width, with two notches at its lower end, the upper end being just below the knee in infants, and the lower projecting 2½ inches below the foot. The splint is applied to the outer side, the leg being first rolled in a flannel bandage to prevent pressure-sores.

Tibialis Posticus.—It is usually recommended to divide this 1½ or 2 inches above the internal malleolus.* The tendon is here separated from the posterior tibial vessels by the flexor longus digitorum.

The surgeon and his assistant, occupying positions as at p. 1174, the exact site of the tendon is defined, if possible, by abducting and bending down the foot. In fat infants it is often quite impossible to feel the tendon, and in these cases a spot midway between the anterior and posterior borders of the leg will be the best guide, as denoting the inner margin of the tibia. The surgeon then introduces a sharp tenotome so as just to touch, if possible, the inner margin of the tibia, taking care to sink the blade sufficiently to open the sheath freely. This being done, a blunt tenotome is introduced through the same opening, and pushed under the tendon; the edge being then turned towards it, and the tibia used as a fulcrum, the tendon is severed, together with that of the flexor longus digitorum. The assistant first relaxes and then extends the tendon, as advised above (p. 1174).

If the artery be cut, as shown by the jetting hæmorrhage and the blanching of the foot, firm pressure must be applied, the foot being first bandaged. No eversion must be practised, but the foot put up in the faulty position for about a week.

Plantar Fascia.†—This may be divided just below its origin from the os calcis, or in advanced cases close to the transverse crease, which is here found in the sole. With regard to this fascia, the surgeon should not tie himself down to any fixed spot, but divide resisting bands wherever they are felt.

Syndesmotomy.—This term has been introduced by Mr. R. W. Parker (*Congenital Club-foot*, p. 62 *et passim*), who believes that in many cases—*e.g.*, severe ones, cases not treated in early life, and in some relapsed cases—the foot cannot be rectified even by multiple tenotomy. He attributes this, not to adhesions, but to the faulty shortness, and unyielding nature of the ligaments. Chief amongst these, in equino-varus, are the ligaments about the astragalo-scaphoid joint. "In these cases there is a capsule made up above and internally by a blending together of the superior astragalo-scaphoid ligament with fibres from the anterior ligament, and the anterior portion of the deltoid ligament below with fibres from the inferior calcaneo-scaphoid ligament. To these are united fibrous expansions of the tendons of the anterior and posterior tibial muscles; together they form an unyielding capsule of great strength, which is attached to the several bones, not in the usual manner, but in adaptation to their altered relative positions. This I would name the 'astragalo-scaphoid capsule.'" Mr. Parker gives directions for dividing this structure which can be made to combine division of the tibial tendons in a manner which I consider far more satisfactory than that already given. Since reading his book I have adopted his method in fourteen cases with good results. I much prefer it to that usually followed.

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* The tendon is here rather farther from the artery, and the surgeon will be above the commencement of its synovial sheath, in which it traverses the internal annular ligament.

† Division of the palmar fascia is fully described at p. 16.

The site chosen for this combined division of tendons and ligaments is a little below and anterior to the tip of the internal malleolus.* Other guides are the site of the astragalo-scaphoid joint, and in older cases the transverse crease which, running down on to the sole, denotes the inversion of the foot. Two tenotomes are required, one of ordinary pattern, and one curved, somewhat sickle-shaped, and with a cutting blade about ½ inch in length.

The surgeon notes the position of the tibial arteries, and the lines along which the tibial tendons are curving towards the internal cuneiform. Having marked at the spot above given the position of these tendons, he enters a sharp-pointed tenotome, the parts being relaxed, just above the posterior tibial artery, and pushes it inwards on to the dorsum to a spot just short of the anterior tibial artery, the knife being entered just below the skin to make a path for the next instrument, which does the work. The curved tenotome is then inserted under the skin, and pushed on, flat-wise, till its tip can be felt over the tibialis anticus; it is then turned blade downwards, the tibialis anticus is felt to give way, and, as the knife cuts on the subjacent bones and cartilages, the ligaments are felt to yield to it, while, as it is withdrawn, its edge divides the tibialis posticus.

The internal saphena vein would seem to lie under this incision, but the hæmorrhage, never marked, is usually very slight. As I have stated, the results in the fourteen cases in which I have used this method have been excellent, though in two I was unable to satisfy myself that the tibialis posticus had given way; in one it was certainly notched, and yielded subsequently.

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* Mr. Parker (*loc. supra cit.*, p. 78) shows that Velpeau and Syme pointed out the possibility of dividing the tendon of the tibialis posticus here.

As here the incision is made from the skin down upon the tarsal bones, I have used irrigation with lotion of mercury perchloride or carbolic acid. The wound is a comparatively free one, but quite subcutaneous, starting from a mere puncture.

As I have stated, I prefer to put up a case of talipes varus after syndesmotomy, with the foot everted at once, on a notched splint like a Dupuytren's, but applied to the outer side. If the tendo-Achillis requires division, this is done in a few days, and the foot put up for about a week, in good position, by Mr. Croft's method of plaster-of-Paris. After this, in early life, the foot must be manipulated *daily* by the surgeon for a while, and several times daily by the friends, the surgeon seeing it at first every other day. If these manipulations are persevered with daily by the mother or nurse, and the case kept under the surgeon's eye, expensive boots and other apparatus will not be needed in children.

Tendo-Achillis.—This should be divided about an inch above its insertion, its narrowest part.

The foot and leg being turned well over on to the outer side, and the tendon being relaxed by the assistant bending the foot downwards, the margins of the tendon are accurately defined. The knife is then introduced vertically close* to the inner side of the tendon till it reaches a sufficient depth to ensure being beneath it;† it is then pushed horizontally across under the tendon till it is felt under the skin by the left index finger, which accurately marks out the outer limit of the tendon; the blade is then turned towards the tendon, which, being put on the stretch by bending up the foot, is divided by a series of levering movements of the handle. Creaking movements, followed by a sudden snap or thud, denote complete division, when the tendon is to be at once relaxed and the knife brought out horizontally.

The Peronæi.—The peronæus longus and brevis occasionally require division. They may be divided simultaneously by entering a tenotome between them and the bone about an inch above the external malleolus. Immediately above this process they are more under cover of the bone. If divided below it, their synovial sheath would be opened, a result requiring greater care in cleanliness.

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* So as to avoid the posterior tibial artery.

† Young operators often do not insert the knife sufficiently deep; they thus, when it is pushed across, get into the tendon instead of beneath it, and so divide it incompletely.

TENOTOMY OF THE HAMSTRINGS.

The patient being rolled two-thirds on to his face, the surgeon stands on the same side as that on which lies the tendon to be divided, facing or turned from the trunk as is most convenient. An assistant stands opposite to him to relax and tighten the tendon.

Biceps.—The exact limits of the tendon being defined, the surgeon introduces a sharp knife close to the inner side of the biceps, so as to get between it and the external popliteal nerve, and, having sunk it sufficiently to get beneath the tendon, pushes the knife outwards, horizontally, till it is felt beneath the skin under the left index, which marks the outer limit of the tendon. The edge being turned towards this, the tendon is extended by the assistant, and divided in the usual way. When this is done, the limb is flexed and the knife withdrawn horizontally.

When the tendon is cut, a cord often rises up close to it. This is the nerve, and the knife must on no account be re-introduced.

If, after tenotomy in long-standing cases, any contracted bands of fascia do not give way to extension, which they will generally do, it is wiser to make a small open wound, antiseptically, and divide them thus, that the surgeon may be certain as to what he is dividing. The wound is united afterwards with one or two horsehair sutures.

Semi-tendinosus and Semi-membranosus.—These tendons can be divided in the same way as the biceps. A contracted knee can generally be straightened after division of the biceps and semi-tendinosus. If it is needful to insert the knife more deeply so as to divide the semi-membranosus, it would be well to use a blunt-pointed tenotome.* In one case of a girl of sixteen, after I had divided the biceps and semi-tendinosus, I had dipped the point of the knife a little more to ensure division of the deeper and larger semi-membranosus. Most profuse hæmorrhage followed from the superior internal articular vessels. Firm padding and bandaging were applied, and the limb put up in the faulty position for four days. No recurrence of the bleeding took place.

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* Messrs. Smith and Walsham (*Man. of Oper. Surg.*), and Mr. Barker (*Man. of Oper. Surg.*) recommend this course for inner and outer hamstrings alike.

TENOTOMY OF THE STERNO-MASTOID.

The two heads are best divided from separate punctures just above the clavicle. The muscle being made prominent by one assistant manipulating the head and another depressing the shoulder, the surgeon, standing facing the patient on the side to be operated upon, defines the limits of the inner border of the sternal tendon, opens the fasciæ sufficiently freely here, and then, taking a blunt-pointed tenotome, insinuates it horizontally behind and close to the tendon till it is felt just beneath his left index finger, which is placed at the outer margin; the edge is then turned towards the tendon, and divides it. It is withdrawn with the usual precautions. The clavicular tendon is divided in a similar way through another puncture.

Care must be taken to avoid the anterior jugular, which runs outwards under the muscle a little above the clavicle, and the external jugular, which lies at a varying level close to the outer border of the clavicular head. If a sharp tenotome were dipped too deeply, the internal jugular might also be wounded.

If any smart venous hæmorrhage occur, a pad of dry gauze should be firmly bandaged on.

Another method is given by some surgeons* of passing a director beneath the heads of the muscle and dividing them on it with a narrow bistoury or tenotome.

Causes of Failure after Tenotomy.

1. Septic troubles. These usually arise from the use of dirty instruments which clean themselves at the patient's expense, or from making an open wound. 2. Incomplete division of the tendon. 3. Division of important structures—*e.g.*, the tibial arteries, the external popliteal nerve, the anterior or internal jugular veins. 4. Non-union of the tendon. 5. Mal-union of the tendon—*i.e.*, adhesions formed by it to adjacent structures, *e.g.*, its sheath or a bone. These must both be extremely rare. 6. Breaking off the point of the tenotome, usually against a bone.

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* Smith and Walsham, *Man. of Oper. Surg.*, p. 29; Barker, *Man. of Oper. Surg.*, p. 74.

CHAPTER IX.

OPERATIONS ON NERVES.

NERVE SUTURE.—NERVE STRETCHING.

NERVE SUTURE.

THIS may be required as a **primary** or **secondary operation**. The latter is accompanied with much more difficulty, owing to the greater retraction of the nerve ends, their bulbous or filiform extremities, their being often buried in scar tissue or matted by it to neighbouring parts—*e.g.*, tendons and fasciæ; to which must be added other unfavourable points—*e.g.*, the atrophy and fatty change in the muscles and the stiffness of the joints.

Primary Suture.—As the mode of uniting nerves will be fully described under the head of secondary nerve suture, the more difficult proceeding, it need not be repeated here. It only remains to emphasize the importance of always resorting to it, and not trusting to spontaneous cure. As an instance of what may be done in very severe cases I may mention the following case:*—A woman of suicidal tendency wounded herself above both wrists. On the right side, the radial, ulnar, and anterior interosseous arteries were divided, the radial and median nerves completely, and the ulnar almost completely. Apparently all the tendons were severed also. On the left side, the radial and ulnar arteries were divided, the radial and ulnar nerves completely, and the median nerve almost cut through. The superficial tendons were quite, the deep partly, severed. The nerves and tendons were sutured. Three weeks later sensation was perfectly normal and active, and passive movement was begun.

Secondary Suture.—The operation on the median or ulnar will be considered, as these are so commonly injured. The following steps must be remembered:—(1) Finding the nerve ends. (2) Freeing and refreshing them. (3) Passing the sutures, and bringing the ends into apposition. (4) Dressing the wound, and the after-treatment.

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* *Lond. Med. Record*, 1881, p. 152; Kraussould, *Centr. f. Chir.*, 1880, No. 47.

1. *Finding the Nerve Ends.*—With accurate anatomical knowledge this is easy. An Esmarch's bandage does not appear to be necessary, as the incision is made parallel with the vessels, and the use of one leads to oozing afterwards.* If bandages are employed, the parts should be made absolutely evascular; careless application will only cause most annoying oozing. An incision, 2 to 3 inches long, being made over and parallel to the nerve ends, the deep fascia and any scar tissue are carefully divided and the ends found, the upper bulbous and the lower filamentous usually,† and not always in a line with each other. They are next freed from the adjacent parts.

2. *Resection of the Nerve Ends.*—This is best effected by *sharp* scissors, with one stroke, and without any bruising. If the nerve is held with forceps, these must hold the sheath only. In case of primary suture, jagged or frayed ends need only be pared sufficiently. In later cases there is much more difficulty. Supposing the upper bulbous end to be taken first, I think that before this is pared the nerve should be carefully stretched,‡ so that dissecting-forceps or any other means of holding the nerve may inflict any necessary damage on parts that will be cut away. It is not necessary to cut away the whole of a bulb; removing the greater part will expose healthy nerve fibres. Mr. Bowlby (*loc. supra cit.*) advises that the section of the upper end should be carried through the uppermost part of the bulb, close to the normal trunk. Not only will numerous young fibres be found here, but, as he points out, the tougher tissue of the bulb affords an excellent hold for the sutures. With regard to the lower end, Mr. Bowlby thinks that all that is needed is "to cut away the extreme end, which, being matted with fibrous tissue and compressed by the surrounding scar, is very likely to contain no nerve tubules. It is seldom necessary to remove as much as ¼ inch, and, however unhealthy the section may look, no good is ever to be gained by a further sacrifice."§

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* Mr. Bowlby, in his Hunterian Lectures (*Lancet*, July 16, 1887), thinks that the parts should be rendered bloodless. If this course is adopted care must be taken to provide sufficient drainage, and the upper bandage must, if possible, be applied sufficiently far from the wound not to interfere with pressing down the parts when the nerve ends are approximated.

† If the distal end be very difficult to find owing to its filiform shape and its being embedded in scar tissue, the wound should be prolonged, the nerve found lower down, and traced up to the distal end.

‡ An Esmarch's bandage, if applied, will be found in the way now, interfering, as it usually must, with the stretching of the nerve.

§ As the whole length of the lower end is in the same condition of degeneration or regeneration throughout, manifestly no good can be done by cutting off

3. *Passing the Sutures and bringing the Nerve Ends in Apposition.*—The suture should be of properly prepared carbolized silk or chromic gut. There has been much dispute as to whether they should be passed through the substance of the nerve itself or only through the sheath. Experience has shown that the former practice is not only harmless to the nerve, but is the method most generally applicable. In a few cases, as in that of a large nerve, where there is but little separation, and where the damage is just inflicted, it may be sufficient to pass the sutures through the sheath only. But in the opposite class of case the sutures should be passed through the nerve itself, and at a sufficient distance from the ends—viz., at least ¼ inch—otherwise when they are tightened they will cut out. Where there is much separation, several sutures should be passed through part of the depth of the nerve, one suture thus taking off some of the tension from its fellows. Another method is to pass one suture completely through the nerve trunk at least ¼ inch from each cut end. When the sutures in the nerve itself have been tied, two or three more very fine ones may be placed in the sheath, where the nerve is large enough.*

In cases of much separation, before any sutures are passed, and again before they are tied, the parts should be as much relaxed as possible, and the upper end brought down by pressing down the soft parts. Stretching the nerve has been already advised (p. 1181).†

All hæmorrhage being scrupulously arrested, and drainage provided by horsehair or a fine tube according to the amount of the disturbance of the parts, &c., dry-gauze dressings are applied, and the limb placed on a well-padded splint in a position which will best retain the nerve ends in apposition with the least discomfort to the patient.

Amount of Nerve Tissue which may be Successfully Removed.—From ½ to ¾ inch is probably an average amount.

Causes of Failure.—1. Wide separation of ends. 2. Atrophy, bulbous enlargement and sclerosis of nerve ends, so marked as to require much trimming, and thus tending to wide separation.

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successive sections in the hope that the cut surface may look more healthy than that which is seen in the first resection (Bowlby).

* To prevent the adhesion of the recently united ends to neighbouring parts, short strands of catgut may be placed beneath them, but this is not essential.

† In cases where, in spite of all precautions, much tension is evidently left on the sutures, it might be well to make use of "stitches of fixation," as in tendon suture (p. 23).

3. Unnecessarily rough handling of the nerve ends. 4. Suppuration of the wound.

Aids in Difficult Cases.—1. Previous stretching of the ends. 2. Approximation of the ends by position of the limb. 3. Using several sutures, which distribute the tension evenly. 4. Perhaps cutting splices, and so joining widely separated ends. The remaining methods must be looked upon, as yet, as experimental only. 5. Autoplastic operation with nerve-flaps. M. Letiévant advises to make a slit through the nerve with a narrow bistoury about $\frac{1}{5}$ inch from the end; the knife being then carried upwards for 1 or $1\frac{1}{2}$ inch, it is made to cut to one side so as to make a flap. The same is then done with the lower end, and the two flaps, being turned towards each other, are united by their raw surfaces. 6. Gluck and Vanlair advise that the nerve ends, whether united or only placed as closely as possible in apposition, should be passed through and left in a decalcified bone-tube, so as to keep the uniting material and granulations in a straight line. 7. Engrafting one nerve upon another. Thus, where the ulnar is too widely destroyed to bring the ends together, the distal end, frayed out, has been stitched to the median, the sheath and superficial fibres of this having been first removed. The success seems to have been slight and partial. 8. Gluck has resected $1\frac{1}{2}$ inch of the great sciatic in chickens, and replaced it by a bit of a rabbit's sciatic sutured in. The birds walked afterwards as well as those treated by direct suture, while nerve resection without suture was followed by paralysis complete at the end of ten weeks.

Period Required for Repair.—The following appears to be a fact not sufficiently recognized. The period required for union after secondary nerve suture is very much longer than is usually supposed to be necessary, owing to the peripheral end being degenerated, the muscles atrophied, and the joints fixed. Complete restoration of function will often require from one to two years. A patient who leaves his surgeon apparently but little better for the operation may return at the end of the above time with his limb practically restored to its natural condition.*

It is the above condition of the muscles and joints which alone puts anything like a limit on the period at which secondary suture can be successfully practised.

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* Mr. Bowlby (*loc. supra cit.*) writes: "If there is one fact more than another which stands out in the clinical histories of patients who have been under my own observation, it is that after the failure of union by first intention, after trophic changes of many kinds, after complete atrophy and degeneration of the paralysed muscles, recovery may yet be complete."

The longer the interval* between the injury and the suture, the more perseveringly must friction, electricity, passive and active movement, and massage be made use of, and the more will patience be required by both patient and surgeon.

NERVE STRETCHING.

This operation, introduced into England in 1880, and much used in the immediately succeeding years, has lately fallen into abeyance, the clinical results having failed to come up to the expectations raised by the operation.

Indications.—Of the following list it is only in the first six that the operation can be considered justifiable.

1. Neuralgiæ.—In all cases where previous treatment has failed, nerve stretching may be practised before division of or removal of part of a nerve.† The conditions justifying this in facial neuralgia have been already given (p. 252). As, however, the results of neurectomy for facial neuralgia are far superior to those of nerve stretching, the latter is only to be recommended on the ground that, owing to the inveteracy of the disease, recurrence is only too probable even after neurectomy, and thus a previous nerve stretching may give a further period of relief. 2. Sciatica.—Nerve stretching is especially indicated here in cases due to rheumatic inflammation of the nerve from exposure to cold and wet.‡ The more definite is the sensation of adhesions broken down at the time of the operation, the better is the prognosis. 3. Locomotor ataxy.—One or both great sciatics have been stretched with a view of improving the lightning pains, the involuntary jerkings of the lower limbs, and the gait.§ While improvement for a varying period may always be expected as far as the first

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* The longest of these with which I am acquainted is a case of M. Tillaux's in which fourteen years had elapsed between the injury to the median and its suture.

† See a paper by Mr. Walsham (*Brit. Med. Journ.*, December 1880), in which the possible causes of relief after nerve stretching for neuralgia are discussed.

‡ Dr. J. P. Bramwell has published (*Brit. Med. Journ.*, June 19, 1880) five cases of this kind, in which much benefit followed stretching the great sciatic.

§ In a case of Dr. Bastian's (*Brit. Med. Journ.*, July 2, 1881), the patient, in an advanced stage of ataxy, experienced so much relief from the stretching of one great sciatic, that he asked for an operation on the other side. An interesting paper by Dr. Cavafy, with nineteen cases collected from different sources, will be found in the *Brit. Med. Journ.*, 1881, pp. 928, 973.

two are concerned, the prospect of improving the ataxy is very doubtful. Furthermore the slow healing of the wound in these cases must be borne in mind. 4. Spasmodic contractions of voluntary muscles.—Here the operation seems to have been followed by success, temporary at least, in a very large number of cases. Where the spasmodic affection is of traumatic origin—*e.g.*, where a limb, after a contusion, is at the same time contracted and the seat of spasmodic movements—stretching of the nerves concerned may be absolutely curative. Quite another class of case—viz., stretching the facial for tic convulsif—has been considered at p. 256. 5. Reflex epilepsy.—Prof. Horsley (*Dict. of Surg.*, vol. ii. p. 61) states that, in those cases of epilepsy where the attack is preceded by violent pains localized distinctly to different nerves, very marked relief (amounting to cure in several instances) has been obtained by stretching the nerve-trunks thus indicated. 6. Anæsthesia of leprosy.—Lawrie, of Lahore, seems to have met with striking success, the fifty cases published being all successful. In the remaining conditions nerve stretching is of more than doubtful benefit. 7. Tetanus.—Owing to the fatality of traumatic tetanus, nerve stretching may be tried here if the case is seen at a very early stage of the disease. But owing to our ignorance of the pathology of the disease, especially with regard to the date at which the spinal cord is affected, and from the difficulty of making sure of stretching all the nerves involved, this treatment cannot be looked upon as hopeful.* 8. Infantile paralysis.—Prof. Horsley (*loc. supra cit.*) states that in 1881 Dr. Bastian had the great sciatic nerve stretched to improve the nutrition in a limb the seat of the above disease. The effect was to markedly increase the temperature and colour of the part, and apparently improve the state of the tissues. The result, however, does not seem to have been such as to find imitators.

Operation (Fig. 108).—The following remarks refer to the great sciatic only, the nerve which has been most frequently stretched.

† The parts being cleansed, an incision about 4 inches long is made over the nerve in the centre of the back of the thigh,

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* Mr. H. Morris points out (*Brit. Med. Journ.*, January 14, 1882) that in one case of acute tetanus claimed to be cured by nerve stretching, the medicinal treatment adopted (Calabar bean) was too active to permit of any conclusion in favour of the operation.

† Ether should be given in preference to chloroform, if possible. In some cases where anæsthetics seemed contra-indicated, the ether spray was made use of. Injections of cocaine might be tried.

commencing about 1½ inch below the lower border of the gluteus maximus. The interval between the hamstrings being hit off, retractors are inserted, and the nerve found a little to the inner side of the biceps. The fatty tissue around it is then carefully incised till the white epineurium itself of the nerve is exposed. The nerve, being most entirely separated from adjacent parts, is now stretched. The force with which this is accomplished must vary somewhat with different cases. Thus, in sciatica, the index finger* being hooked under the nerve, this should be raised well out of its bed in the hope of adhesions being felt to give way both at the part stretched and at a distance also.

In the case of locomotor ataxy the same amount of stretching—viz., hooking up the nerve some 2 inches above the level of the skin and some 4 or 5 above its bed, this being repeated twice in a centrifugal and centripetal direction—has been followed by satisfactory results. In other cases the pull has been more forcible, care being taken to lift the limb off the table several times. In any case the pull must be without jerks, steady and continuous, and kept up for some three minutes.† The direction of the pull, whether downwards from the trunk or upwards from the limb, has been a good deal disputed. Mr. Marshall (*Bradshawe Lecture*, p. 28) thought that in neuralgia the stretching should be performed both ways. In ataxy it is essential to stretch down from the body.

The nerve, being found to be loose and elongated, is replaced in its bed, any bleeding points are attended to, drainage provided, and the wound carefully closed. Antiseptic precautions must be made use of throughout, and the limb kept quiet with a splint or sand-bags. The tardy healing of the wound in cases of ataxy has been already alluded to.

In cases of stretching for sciatica, gentle movements of the limb should be begun as soon as possible to prevent the re-formation of adhesions.

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* In the case of smaller nerves a blunt hook would be employed.

† Mr. Marshall (*loc. supra cit.*) thought that a force equal to 30 lb. or 40 lb. should be the limit for the sciatic. He thus gave an idea of the above force: "If I first pull as hard as I imagine I should do upon a living sciatic nerve during an operation, I find that the force employed is about equal to 20 lb.; but if I pull very hard, it is increased to 30 lb., and that, I believe, is as hard as a surgeon could well pull when holding a soft nerve between his finger and thumb."

PART VI.

OPERATIONS ON THE VERTEBRAL COLUMN.

SPINA BIFIDA.—TREPHINING THE VERTEBRAL COLUMN.

SPINA BIFIDA.

Indications.—I cannot do better than quote here the conclusions arrived at by the Clinical Society's Committee appointed to report on this affection :—"1. Notwithstanding many failures, the plan of treatment by injection is the best with which we are acquainted, and the only one which we feel justified in recommending. 2. A more careful selection of cases than has hitherto been made is necessary. 3. Marasmus, hydrocephalus, and intercurrent disease contra-indicate the operation. 4. In cases in which the operation may nevertheless be legitimately performed, we should consider the following as unfavourable circumstances :—(α) Distinct evidence of the cord being in the sac, as shown by umbilication or a longitudinal furrow ;* (β) A very thin membranous or ulcerated sac ; (γ) Previous rupture of the sac ; (δ) The occurrence of a distinct impulse between the tumour and the anterior fontanelle, or a sac the contents of which are easily returned into the spinal canal ; (ε) A very early age of the patient. 5. The best result is to be hoped for in children who have reached the age of two months, in whom there is no paralysis or hydrocephalus, and when the sac is covered by healthy skin."

Operations.—1. **Injection with Morton's Fluid.** 2. **Simple Tapping and Drainage.** 3. **Excision.**

All the above are liable to be followed by septic meningitis aided by the constant soaking away of cerebro-spinal fluid, especially where the coverings of the sac are thin and unhealthy.

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* Other points which make it probable that nerve trunks or the cord, or both, are present in the sac are paralysis of the sphincters or lower extremities, a large sessile tumour with a broad base, and the appearance of cord-like bands when the sac is thin enough to transmit light.

1. **Injection with Morton's Fluid.**—Owing to the large number of successes which have attended the use of this method, and the fact that it was recommended by the Committee of the Clinical Society, it is the only one which will be given here at any length. It is impossible to point out too strongly to my younger readers that it is only by a judicious selection of cases that any success can be expected.*

The sac being cleansed, a syringe which will hold about 2 drachms of the iodo-glycerine solution is chosen, and a fine trocar. The calibre of this must not be too fine for the thick fluid† which has to pass through it. The puncture into the swelling should be made well at one side, obliquely through healthy skin, and not through the membranous sac-wall, the objects being to avoid wounding the cord or nerves, and also to diminish the risk of leakage of the cerebro-spinal fluid. Unless the sac is very large it is probably better not to draw off much, if any, of the fluid from the sac on the first occasion. The position of the child during the injection has been a good deal dwelt upon, most recommending that it should be upon its back. The Clinical Society's Committee advise that the child should be laid upon its side. About a drachm is the quantity which they recommend. Every care must be taken to prevent any continued escape of the cerebro-spinal fluid, now and later, it being clearly understood that any such leakage, which is most difficult to prevent, will lead to septic meningitis and death. When the needle is withdrawn the puncture should be pressed around it, and immediately painted with collodion and iodoform, a dressing of dry gauze being also secured with collodion. I prefer to give a little chloroform to prevent any crying and straining at the time. The child should be kept as quiet as possible afterwards, on its side, and an assistant should make sure, for the first hour at least, that no leaking is going on. Shrinking of the cyst, continuing steadily, shows that all is well. If the injection fail altogether, or only cause partial obliteration of the sac, it should be repeated at intervals of a week or ten days. Of my three cases one was successful.

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* The Clinical Society's Committee collected 71 cases treated by this method. Of these, 35 recovered, 27 died, 4 were relieved, and 5 unrelieved. In a letter to the Committee (dated May 11, 1885) Dr. Morton was able to refer to 50 cases thus treated. Of these, 41 appear to have been successful, and 9 unsuccessful.

† The fluid is iodine, gr. x.; iodide of potassium, ʒj; glycerine, ℥j.

2. **Simple Tapping and Drainage.**—This consists of either tapping with a very fine trocar and carefully sealing the opening, or inserting a single piece of horsehair as a drain. I have had one successful case treated by the former method, and four unsuccessful ones. The use of the horsehair drain is not to be recommended, as the leakage cannot be kept sweet.

3. **Excision of the Sac.**[*]—There is no doubt that this method has met with a considerable amount of success, but with regard to this the following points must be reckoned with:—(1) It is probable that many cases of failure have not been reported. (2) In many of the cases it is not stated with sufficient clearness whether nerves were present or not. (3) The patient is exposed to the grave dangers of removal of the nerves or cord.

The cases best suited to this method are those, of course, where there is something of a pedicle, or where the gap in the bones is very small or closed.[†]

Mr. Robson has recorded[‡] four cases in which he excised the sac with the aid of the eucalyptus spray, suturing the meningeal and cutaneous flaps respectively. Three cases did well. Nerves do not appear to have been present in the sac. Mr. Robson suggests that if this complication is present, portions of the cyst-wall might be removed from between the nerves, and the remains of the sac placed in the opening in the bones and covered over with skin.[§]

Causes of Failure after the Radical Cure of Spina Bifida.—1. Leakage and septic meningitis. 2. Convulsions and rapid death.[||] 3. Paraplegia. The setting in of this after injection may be temporary or permanent. 4. Hydrocephalus. This also may make its appearance after the injection with iodo-glycerine. 5. No result, the swelling progressing unaltered.

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[*] The Clinical Society's Committee collected 23 cases treated by excision of the sac. Of these, 16 recovered, 7 died. They point out that no mention of the contents of the sac is made in 6 cases; that nerves were certainly absent in 16 cases; and that in 1, which was fatal, they were certainly present (*Trans.*, vol. xviii. p. 380).

[†] Dr. Sinclair (*Dub. Journ. Med. Sci.*, 1886, vol. i. p. 199) records a case of successful excision. Here all communication with the spinal canal was shut off by a strong vascular cord. No alteration in tension had occurred when the child cried, and continuous pressure on the swelling had produced no head symptoms.

[‡] *Brit. Med. Journ.*, April 4, 1885.

[§] Any one attempting this method would be wise to remove portions of the sac from its sides only, suturing the edges of the wound.

[||] Mr. Clutton, who brought a successful case of Dr. Morton's treatment before the Clinical Society (*Trans.*, vol. xvi. p. 34), mentioned another in which this treatment was immediately followed by fatal convulsions. The same proved fatal in about ten hours in a case under my care. Mr. Bennett, during the above discussion, mentioned a case in which, owing to the child being indisposed at the time, he declined to operate. On its way home the child died of convulsions.

TREPHINING THE VERTEBRAL COLUMN.

This rare operation, which has of late been revived, must be referred to here under the following indications:—A. *Cases of injury.* B. *Cases of inflammatory disease—e.g., Pott's curvature.* C. *Cases of new growth.*

A. *Cases of Injury.*—Here the operation has been suggested by the analogous one performed on the skull, and the large amount of success which has followed it. But the analogy is, for several reasons, a deceptive one. Thus, owing to the small size of the cord, an injury which would only damage the brain slightly, almost inevitably destroys the structure of the cord throughout its thickness. Again, it must be remembered that a fragment of bone often inflicts injury upon the cord instantaneously and in a moment, and that irremediable* damage may be done, though all deformity may be removed by raising and straightening the patient, and by the elasticity of the bones and the contraction of the muscles. Further, the cord may be most severely damaged, though its theca shows no sign of injury.

Again, when the surgeon trephines the skull, he not only hopes that the damage is slight and often of a removable nature, but he also believes that the only damage to the bones is that which lies close to his trephine and finger. But in the case of the spine we are faced by this dilemma:—If the fracture has been from direct violence, and the spinous processes and laminæ have been driven in, it is only too probable that when these are elevated the spinal cord, so limited in size, will be found too much damaged to profit by the operation. On the other hand, if the fracture has been caused by indirect violence, it is almost certain that the bodies of one or more vertebræ will have been crushed down, and a portion shot back into the canal.† In this case the fragment which has inflicted the injury, and which is

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He remarked that if he had used the injection, this would have been credited with the convulsions.

* Hence accounting for the very grave fatality of fractures of the spine, a fact held by some to justify trephining. The above account is taken from my article on "Injuries of the Back," *Syst. of Surg.*, vol. i. p. 673.

† This is a very common condition, judging from museum specimens. It is well illustrated by Figs. 93 and 94 from my article to which I have alluded above.

keeping up the irritation, will be in front of the cord and out of reach, even if the cord were in a condition to be much benefited by its removal. A surgeon trephining the spine under these conditions would be like one who trephined the skull in order to remove depressed fragments of the vertex, when all the time a portion of the base of the skull was lying jammed into the under surface of the brain.

But it is not only in the damage, but in the violence of the fracture also that no analogy lies between the two cases. Fracture of the spine is usually due to indirect violence, as when the neck is broken by a fall on the head, or when the lower dorsal spine is fractured by a fall of a sack upon the shoulders. Even when the fracture is due to direct violence, it is of an entirely different nature to that for which the surgeon hopes to trephine successfully in the skull, and one far more likely to produce extensive and crushing damage—*e.g.*, the fall of coal or earth, or a fall from a height upon a projecting body.

It remains to be shown that trephining the spine is not only likely to be void of any good results, but that it also involves serious risks and entails additional dangers of its own. Thus, the conversion of a simple into a compound fracture, the formation of a large, deep, and more or less ragged wound, the risk of subsequent suppuration with free access to the sheath of the cord, the opening up of inflamed cancellous tissue with its various channels and exposure of these to possible suppuration—all these have, I admit, been lessened by the use of antiseptic precautions. But the risk, though diminished, remains; the large amount of venous oozing tending to soak quickly through in this region can only be met by frequent dressing. And though it has been shown that in some of these cases the wound has healed quickly, and though no improvement has followed, the spinal column has not been fatally weakened by the removal of the laminæ and spine, yet the weakening for a time must be considerable; and it must be remembered that by the removal of these structures the mobility of the fractured parts will be much increased, and when any attempt is made to vary the position of the patient in bed, there will be, for some time, a risk of disturbing the fragments and thus of inflicting further injury on the cord.

It will be seen from the above that my own opinion is averse to any surgical interference in cases of fractured spine, owing to the amount of damage to the cord being usually, from the first, irreparable. To quote two more recent writers: Mr. Thorburn (*Surgery of the Spinal Cord*, 1889, p. 160) comes to the same conclusion, but draws an important distinction between the cord and its nerves. This authority would advise trephining in the case of injury below the first lumbar, where in injuries to the cauda equina, if the symptoms have lasted six weeks, the mischief is probably due to some removable cause of pressure —*e.g.*, displaced bone or cicatricial tissue. Another and very different class of exception to the doctrine of non-intervention in injuries to the spinal cord is, as Mr. Thorburn points out, furnished by those cases in which the injury has affected, not the bodies, but the arches of the vertebræ. To these might be added one more, in the words of Mr. Le Gros Clark—viz., "the recent intrusion of a spiculum of bone within the theca, whereby the cord is pushed or irritated." Dr. J. W. White (*Ann. of Surg.*, July 1889) strongly advocates surgical interference in fractured spine, believing that fracture of the laminæ and spinous processes, and therefore relievable pressure on the cord, will not be found so rare as has been usually believed. I fear the weight of pathological evidence is all the other way. But if these cases in the future are proved to be more frequent, how are they to be diagnosed? The chief points will probably be: A history of a direct injury; mobility and displacement, laterally or downwards, of the spinous process; great local tenderness; the usual symptoms of swelling, &c.; and paraplegia less marked than usual.

B. *Cases of Inflammatory Disease—e.g., Pott's Curvature.*—Interference here will be but very rarely called for. For while, on the one hand, the pathology of these cases is much more hopeful than in fracture, the paralysis here being due, not to pressure of displaced vertebræ, or to irremediable damage of the cord—*e.g.*, myelitis, degeneration—but to the results of a chronic, localized, external pachymeningitis, producing pressure by a mass of scar-like connective tissue. On the other hand, we have abundant evidence that paralysis, even when of long duration, has a marked tendency to recovery, if the treatment by absolute rest in the recumbent position is vigorously enforced, and if potassium iodide is pushed in large and frequent doses, after the American method.* Surgical interference should only be adopted where the above have failed, especially if incontinence and bed-sores are present also.

C. *Cases of New Growth.*—Mr. Horsley has here, as in so many other instances connected with the surgery of the central nervous system, operated with brilliant success (*Med.-Chir. Soc.*, vol. lxxi. p. 383). The patient was one of Dr. Gower's, aged forty-two, and his chief symptoms were complete paralysis of the lower limbs and abdomen, the former being frequently flexed in clonic spasms, the pain accompanying these being extremely severe. There was loss of tactile sensibility as high as and involving the distribution of the fifth dorsal nerve. The bladder and rectum were completely paralysed. The growth proved to be an almond-shaped fibro-myxoma resting on the left lateral column, in which it had formed a deep bed, and adherent to the fourth dorsal nerve.* The patient recovered perfectly, the report being continued up to a year after the operation.

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* In an adult gr. x–xx is given every half-hour, if possible, in a large wine-glass of milk. I suggested this with marked relief in a hospital case of Dr. Pye-Smith's with Pott's curvature and paraplegia.

Operation of Laminectomy, or Trephining the Spinal Column.—The patient being placed as far as is safe in the prone position, and the skin rendered scrupulously clean, an incision is made down to the spinous processes, with its centre opposite the point of the angle of curvature, the site of the supposed displacement or of the tumour. The deep fascia † and the tendinous attachment of the muscles are then cut from the spines, and the muscles completely detached from these processes, the laminæ, and from the transverse processes as far as is necessary, by the edge of a short, stout scalpel. To prevent hæmorrhage, Spencer Wells' forceps are quickly applied, and then sponges are tightly packed into the incision on one side of the spine, while the operation is proceeded with on the other. Any vessels that require it being tied, and the muscles held back with retractors, the periosteum is reflected with a suitably curved elevator. Two or three spinous processes, if unfractured, are then cut off close to their bases with powerful bone-forceps with jaws at an obtuse angle. The laminæ may be next removed by Hey's saw, aided by a trephine, but the most speedy method is by using Mr. Horsley's bone-forceps devised for working at the bottom of a deep steep wound cavity. In the case of fracture, any loose bone will of course be tested and removed by sequestrum-forceps. The ligamenta subfava are next cut through with a sharp knife. The dura mater, covered with peculiar vascular fat, is next exposed. To avoid troublesome hæmorrhage from the numerous veins of this tissue, it must be opened strictly in the middle line, and then kept with broad retractors pressed against the sides of the spinal canal, while the dura mater is opened (Horsley). This being done with knife and dissecting-forceps in the middle line, the cerebro-spinal fluid escapes freely, and should be mopped out with sponges as long as it flows. If the patient is kept quiet, and the spine horizontal, and the head not raised, this flow will soon cease (Horsley). The growth is then removed, and the cord inspected and palpated very freely, so as to reveal any change in its density. If it be suspected that a fragment of bone or a new growth be pressing against the front of the cord from one of the vertebræ, Mr. Horsley advises that the sides and anterior aspect of the cord be explored by the careful passage of an aneurism needle. Where the dura mater has been opened for exploratory purposes only, it should be sutured with fine catgut, one end being left open. If any growth has been removed from within, it will probably be wiser to provide for drainage of the sub-dural space with horsehair. The extra-dural space should be drained with a small tube.

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* Much difficulty was met with, even in Mr. Horsley's hands, in localizing the growth. Six and parts of a seventh laminæ were removed; and it was found that the growth was situated 4 inches above the level of complete anæsthesia. An elaborate list of intra- and extra-dural growths of the spinal cord will be found in the appendix to his article.

† As Mr. Horsley finds it needful to divide the deep fascia, not only along the spinous processes, but also at right angles opposite the middle of the incision in order to prevent its resisting proper separation of the sides of the wound.

In cases of Pott's curvature dense scar tissue, granulation tissue, pus, or a tubercular mass may present themselves when the dura mater is exposed. In some it will be sufficient to take away the diseased material, till pulsation of the cord reappears; in others the tougher leathery substance must be snipped away with scissors till the cord is exposed with a surface made as smooth as possible, and it is clear that, if not pulsating, it is not constricted. Any carious bone that is within reach will of course be removed by the sharp spoon. In these cases of Pott's curvature drainage will be especially required.[*]

Causes of Failure and Death after Laminectomy, &c.—I have only space to allude to these very briefly: (1) Shock. (2) Hæmorrhage. This seems to have been rarely troublesome; the extradural plexus appears to be usually obliterated in cases of Pott's curvature. (3) Respiratory trouble, probably largely due to the prolonged anæsthetic.* (4) Septic complications. (5) Tubercular or other secondary deposits elsewhere. (6) Temporary improvement followed by a relapse.

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[*] As this operation is still *sub judice*, reference should be made, in addition to the writings quoted above, to the following:—(1) In cases of injury, Macewen, *Brit. Med. Journ.*, 1888, vol. ii. p. 308; Keetley, *ibid.*, p. 421; Duncan, *Edin. Med. Journ.*, 1889, p. 830; E. Hart, a case of M. Péan's, *Brit. Med. Journ.*, 1889, vol. i. p. 672; H. W. Allingham, *ibid.*, p. 838. (2) In cases of Pott's curvatures, Macewen and Duncan (*loc. supra cit.*); Wright, *Lancet*, July 14, 1888; W. A. Lane, *Brit. Med. Journ.*, April 20, 1889; *Lancet*, July 5, 1890; Abbe, *New York Med. Journ.*, Nov. 24, 1888; Kraske, *Centr. f. Chir.*, 1890, Heft 25. Several of the above cases have been reported so soon after the operation that their value would be much increased by the authors giving later details. (3) Cases of new growths—Dr. Gowers, Mr. Horsley's paper (*loc. supra cit.*), and his appended table. See also Dr. J. W. White's paper (*loc. supra cit.*), and his table of the most obvious diagnostic points, p. 32.

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* In one case (Deaver, *Inter. Journ. Med. Sci.*, Dec. 1888) the respiration became much embarrassed towards the end of the operation; this, continuing till the patient's death three days later, was attributed to injury to the phrenic nerve with an exploring needle. The dura mater, thickened and adherent to the base, had been thus explored after removal of the third and fourth cervical arches, which were carious.

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